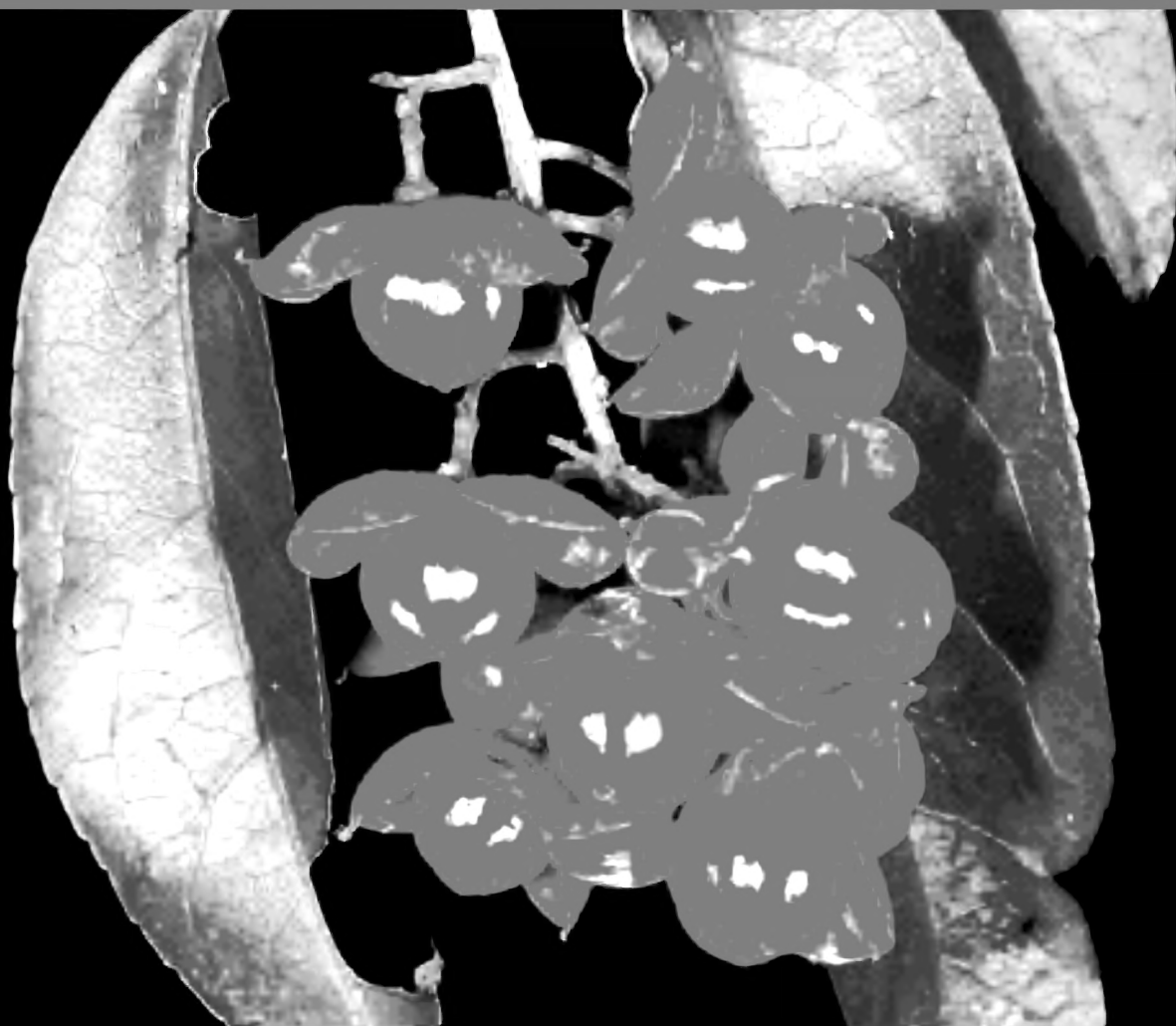


# Australasian Plant Conservation

BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

VOLUME 21 NUMBER 3 • DECEMBER 2012 – FEBRUARY 2013



## Victorian Orchid Conservation

Seeds behaving badly: Conservation of rainforest species

Sowing seeds: bridging the gap between ex situ collections and reintroduction

Efforts to enhance populations of the Wee Jasper Grevillea: Successes and failures

The endemic flora of Norfolk Island: Conservation challenges on a remote oceanic island

Research and conservation initiatives for the vulnerable *Acacia carneorum*: a model for plant species conservation in Australia?

And much much more ...

CONFERENCE EDITION

PLANT CONSERVATION IN AUSTRALIA: ACHIEVEMENTS AND FUTURE DIRECTIONS

### ANPC National Office

GPO Box 1777  
Canberra, ACT 2601, Australia  
**Ph:** (02) 6250 9509  
**Fax:** (02) 6250 9528  
**Email:** [anpc@anpc.asn.au](mailto:anpc@anpc.asn.au)  
**Web:** <http://www.anpc.asn.au>

### National Office Staff

Tricia Hogbin and Meryll Bradley

### Volunteer

Liz Myszk

### ANPC Committee

|                                    |  |
|------------------------------------|--|
| <b>President</b><br>David Coates   | <b>Vice President</b><br>Paul Gibson-Roy |
| <b>Treasurer</b><br>Adrian Fethers | <b>Secretary</b><br>Zoë Smith            |

### Committee Members

Paul Adam, Doug Bickerton, Anne Cochrane,  
Phil Collier, Paul Donati, Sally  
Jacka, Helena Mills, Noushka Reiter,  
Mark Richardson, David Taylor.

### ANPC News

To subscribe or unsubscribe go to  
<http://anpcnews.blogspot.com/>.  
To post a message, send a request to  
[anpc@anpc.asn.au](mailto:anpc@anpc.asn.au).

### Australasian Plant Conservation

#### Editor

Selga Harrington

#### Editorial Team

Paul Adam, Anne Cochrane, Phil Collier,  
Paul Donati, Sally Jacka

#### Layout & Graphic Design

Siobhan Duffy

*Australasian Plant Conservation* is produced by the  
ANPC Inc. with assistance from the Australian National  
Botanic Gardens.

*Australasian Plant Conservation* is printed on  
recycled paper.  
ISSN 1039-6500

### New Zealand Plant Conservation Network

**President** Philippa Crisp  
**Secretary** John Sawyer  
PO Box 5086 Wellington, New Zealand.  
Email: [info@nzpcn.org.nz](mailto:info@nzpcn.org.nz)  
Web: [www.nzpcn.org.nz](http://www.nzpcn.org.nz)



### ANPC Inc. Mission Statement

*"To promote and improve  
plant conservation"*

### Contributing to *Australasian Plant Conservation*

*Australasian Plant Conservation* is a  
forum for information exchange for all  
those involved in plant conservation:  
please use it to share your work  
with others. Articles, information  
snippets, details of new publications or  
research, and diary dates are welcome.  
**The deadline for the March–May  
2013 issue is Friday 15 February  
2013.** The issue will contain papers from  
the ANPC 9th National Conference.  
General articles are also very welcome.  
Please contact Selga Harrington if  
you are intending to submit an article:  
[selga.harrington@gmail.com](mailto:selga.harrington@gmail.com)

Authors are encouraged to submit  
images with articles or information.  
Please submit images as clear prints,  
slides, drawings, or in electronic format.  
Electronic images need to be at least  
300 dpi resolution, submitted in at least  
the size that they are to be published,  
in tif, jpg or gif format. Guidelines for  
authors are at: [http://www.anpc.asn.au/  
anpc/pdffiles/APCGuideContrib.pdf](http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf).

Please send articles, no more  
than 1200 words, as a MS Word  
file (2000 compatible) by email to:  
[selga.harrington@gmail.com](mailto:selga.harrington@gmail.com).

Opinions expressed in this publication are those of the  
authors and are not necessarily those of the ANPC or  
its sponsors. Material presented in *Australasian Plant  
Conservation* may be copied for personal use or published  
for educational purposes, provided that any extracts are  
fully acknowledged. Where any material is credited to and/  
or copyright to another source, please contact the original  
source for permission to reprint.

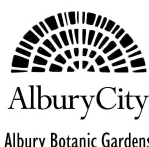
## ANPC Major Sponsors

### GOLD SPONSORS



AUSTRALIAN NATIONAL  
BOTANIC GARDENS

### OTHER SPONSORS



**Front cover:** Staff Climber (*Celastrus  
australis*) capsules. Photo: Graeme Errington.

**Printed by:** Trendsetting, Canberra.

## Contents

|  |    |
|--|----|
| From the editor by <i>Selga Harrington</i> .....   | 2  |
| President's report by <i>David Coates</i> .....  | 2  |
| ANPC's 9th National Conference by <i>Mark Richardson</i> .....   | 4  |
| Efforts to enhance populations of the Wee Jasper Grevillea: Successes and failures<br>by <i>John Briggs and Scott Seymour</i> .....  | 6  |
| Kangaroo Island Nationally Threatened Plant Project: making a difference to Kangaroo Island's threatened flora<br>by <i>Michelle Haby and Heiri Klein</i> .....  | 8  |
| <i>Euphrasia arguta</i> : management of a species previously presumed extinct by <i>Doug Binns</i> .....   | 10 |
| Victorian Orchid Conservation by <i>Noushka Reiter, Richard Thomson, Neil Anderton, Wendy Bedggood, Chris Jenek, Rob Cross, Julie Whitfield, Ann Lawrie, Gail Pollard, Mary Argall, Glen Johnson and Karen Lester</i> .....                                  | 12 |
| Sowing seeds: bridging the gap between ex situ collections and reintroduction<br>by <i>Lydia Guja, Tom North, David Taylor, Joe McAuliffe</i> .....  | 14 |
| Seeds behaving badly: Conservation of rainforest species by <i>Graeme Errington, Peter Cuneo and Catherine A. Offord</i> .....   | 17 |
| The endemic flora of Norfolk Island: Conservation challenges on a remote oceanic island by <i>Kevin Mills</i> .....  | 19 |
| Research and conservation initiatives for the vulnerable <i>Purple-wood Wattle</i> : a model for plant species conservation in Australia? by <i>Andrew Denham, Tony Auld, David Ayre, Cairo Forrest, Amy Gilpin, Eleanor O'Brien and David Roberts</i> ..... | 22 |
| A phylogenetic and morphological approach in a key Australian plant genus, <i>Brachyscome</i> by <i>Megan J Hirst</i> .....  | 24 |
| Saving private rhizomes: private land initiatives which encourage and support in-situ plant conservation<br>by <i>Jeff Kelleway and Lynn Webber</i> .....  | 27 |
| Non Government Organisations – research and botanic gardens by <i>David Coutts</i> .....   | 29 |
| Horned Pondweed at Sydney Olympic Park by <i>Swapan Paul and Tina Hsu</i> .....  | 31 |

## Regular Features

|  |    |
|--|----|
| Report from New Zealand Plant Conservation Network ..... | 34 |
| ANPC workshop report.....                                | 34 |
| Conferences and Workshops.....                           | 36 |
| ANPC Corporate Members .....                             | 37 |

## From the editor

Selga Harrington

Parsons Brinckerhoff

Welcome to the summer edition of *Australasian Plant Conservation*! This edition of *Australasian Plant Conservation* contains papers from ANPC's 9th National conference, held in Canberra late last year. The conference was entitled *Plant Conservation in Australia: Achievements and Future Directions* and had six primary themes:

- threats
- conservation policy
- plant conservation strategies
- ecological restoration
- role of the NGO sector
- vegetation, soil and water context.

This edition begins with the report by ANPC President David Coates at the Annual General Meeting in November 2011 and is followed by a report of the conference providing a brief overview including the celebrations to mark ANPC's 21 years. This is followed by a range of papers covering the conference themes, as well as a general article on aquatic ecology assessment at Sydney Olympic Park.

The edition concludes with the regular features: Report from New Zealand Plant Conservation Network, Report on recent ANPC workshops and Upcoming conferences.

Happy 21st ANPC, and happy reading!

## President's report

David Coates

This year is the ANPC's twenty first year of promoting and working for plant conservation in Australia culminating in our 9th National Conference in Canberra based on the theme *Plant Conservation in Australia: Achievements and Future Directions*. In my first year as President I have been impressed by the dedication and breadth of knowledge of ANPC members which was particularly evident at the Conference. I am convinced that the ANPC with its broad membership of scientists, land managers, government departments, industry, the volunteer conservation movement and the broader community is in a great position to maintain and enhance its key role in promoting linkages between the many interest groups that are dedicated to the conservation of Australia's plant species, communities and ecosystems.

### 2012 Conference

The conference not only highlighted current major issues and new directions for plant conservation in Australia but provided a focus for celebrating the ANPC's 21st anniversary. Highlights were the 21 "gum salute" at the Australian National Botanic Gardens (ANBG) and the conferring of life membership on our past Presidents Bob Makinson (2007-2011), Judy West (2003-2007) and

Kingsley Dixon (1999 – 2003), and Henry Nix as the Chair of the ANPC Advisory Committee (1992-1998). The 21 "gum salute" was a particularly special occasion with 21 ANPC founding members, past presidents, long term members and a number of others representing those who have made major contributions to the ANPC over the past 21 years, each planting a eucalypt seedling in the Eucalypt lawn of the Australian National Botanic Gardens.

In developing the conference theme it has been of interest for us to look back at the progress and achievements of the ANPC since its inception. In 1991 the Australian National Botanic Gardens acted to co-ordinate the *ex situ* conservation of rare and threatened plants by organising the conference "Protective Custody? - Ex Situ Plant Conservation in Australasia". That conference had among its key outcomes the intention to encourage communication and networking so that the diverse range of groups involved in plant conservation can be better informed and coordinate their efforts. Out of this came a proposal for the establishment of the Australian Network for Plant Conservation. While the initial focus of the ANPC was *ex situ* conservation this rapidly evolved to encompass all aspects of plant conservation and in particular bridging the gap between *ex situ* and *in situ* conservation approaches.

The 2012 conference provided an opportunity to not only discuss the achievements and future direction for plant conservation in Australia but also for the ANPC to consider its future directions. This was the focus of the first workshop chaired by Bob Makinson on day three. The outcomes from that workshop are still being worked up but some of the key recommendations included:

- Development and dissemination of seed sourcing guidelines and standards for ecological restoration for Australia.
- The need to better facilitate the transfer of research outcomes for seed banking and seed sourcing protocols (provenance) from scientists to practitioners.
- Technical advice on the management of remnant bushland needs to be better targeted to local communities and delivered at a regional scale. There is considerable scope to increase the capacity of local communities to contribute toward the management and conservation of their local bushland.
- The need for increased recognition among the broader Australian community of the inherent value, beauty, utility, diversity, and cultural value of Australia's unique flora.
- We need to better sell the story of the work that many Australians are already undertaking to help protect and conserve Australia's unique flora.

The plenary session on the first day was an exceptional blend of themes covering climate change, threatening processes and threatened species, ecological restoration, conservation policy, strategies for plant conservation and the role of the NGO sector. A number of the speakers recognised the significance of climate disruption (change), a term coined by Professor Henry Nix, and the impact it will have on Australian flora in the coming decades. They emphasised the need for development of new innovative approaches in seed science, ecological restoration and habitat management.

I would like to thank the conference organising committee: Mark Richardson, Bob Makinson, Merryl Bradley, Tricia Hogbin, Rosemary Purdie, Rainer Rehwinkel, Zoe Smith, David Taylor, Roger Good, Simon Nally and Kristiane Herrmann for their huge effort in making the conference the success it was. In particular Mark Richardson worked tirelessly to ensure that the conference ran smoothly and his efforts in arranging the "21 gum salute" and the tour of the National Arboretum Canberra were greatly appreciated by all of us. Likewise I thank Merryl Bradley and Tricia Hogbin for their exceptional efforts in dealing with the numerous details and issues that arose each day.

### Workshops and outreach

While the conference was a focus for many of us over the last few months there have been a significant number of other events in 2012. We have continued the Myrtle Rust workshops thanks to the efforts of Bob Makinson with the latest one in Cairns at the end of 2011. Three other

themed events involving workshops and courses have been successfully rolled out over the last year thanks to Tricia Hogbin.

Two workshops "Translocation of Threatened Plants" were held in Canberra (27 and 28 March) and at Mt Annan (6 – 7 November), and a seed collection, storage and use workshop was also held at Mt Annan prior to the translocation workshop.

We also held two more workshops on the management of native vegetation in Travelling Stock Reserves (TSRs), funded by the NSW Environmental Trust. These were "Jewells in the Landscape: Managing remnant native vegetation, 17 – 18 September, in Scone NSW and "Plant identification for grassy ecosystems" 24 – 25 September, in Deniliquin NSW. All the workshops had 30+ participants and all had positive feedback given by the participants.

Our outreach efforts have been expanded through a range of Social Media accounts that have now been set up for ANPC and the buttons have been added to the ANPC website while the ANPC Flickr photo sharing page is now live.

Our bulletin, *Australasian Plant Conservation*, has continued to publish high-quality articles relevant to a broad range of plant conservation practitioners and managers, under the editorship of Selga Harrington. Issue themes for the year have been: monitoring and plant conservation, monitoring and community involvement, bushland restoration and landscape restoration.

### Funding and staffing

Our financial situation will be reported on in detail separately at the AGM but we continue to diversify our sources of income with this year producing a reasonable surplus compared with the previous three years where there were relatively small surpluses or deficits.

Workshop registrations were a key source of income with the Myrtle Rust workshops a significant component. We were also successful with grants from:

- NSW Environmental Trust, NSW Environmental Education Program for preparing and presenting workshops on Managing Native Vegetation on Travelling Stock Reserves
- NSW Environmental Trust, Lead Environmental Community Group Grants
- Dahl Trust to support a series of Myrtle Rust workshops
- Voluntary Environment and Heritage Organisations program.

We also applied unsuccessfully for funding from the NSW Environmental Trust Environmental Research Grants program and the NSW Environmental Trust Environmental Education program, The Norman Wettenhall Foundation, the Biodiversity Fund and Caring for Country. While unsuccessful a number of these grants were developed up as partnerships with the Australian Seedbank Partnership

and Greening Australia, and both organisations are keen to partner with ANPC in the future. In particular they recognise the skills ANPC has in community outreach and communication. I see value in ANPC exploring funding opportunities with these organisations as further funding rounds are announced for the Biodiversity fund and Caring for our Country.

We have had some staff changes during the year. Sue Mathams finished in February moving to the Department of Defence for a full time job. I echo Bob's comments from last year that Sue has been a pleasure to work with and made a significant contribution to the ANPC during her time as Project Manager. It was great to see Sue at the 2012 Conference and that she is still maintaining close links with us.

Sue was replaced by Tricia Hogbin, who has a long history with the ANPC and in both research and plant conservation. Tricia has in the past been on our Committee and Editor of APC, and is currently co-convenor of our Translocation Working Group. Tricia's efforts in delivering the range of workshops and developing up grant applications this year has been outstanding.

Merryl Bradley our Business Manager continues to give so much to the organisation and I would like to personally thank Merryl for her support in this my first year as President. It has been a rapid learning curve for me and Merryl's help and advice has been indispensable. Also providing important support in the office are volunteers Liz Myszk and Mark Graeme. Their efforts are much appreciated.

I am grateful to all Committee members for their tremendous support over the year. It is sometimes not easy to devote the time that is needed to maintain active involvement as committee members given that most members have significant commitments elsewhere.

Yet the involvement and participation in the committee by all Committee members' is a clear demonstration of their dedication to the ANPC and its goals in improving plant conservation.

### The coming year

A number of workshops are already in the planning stage for next year including two in the Sunshine Coast, Queensland: Seed collection, storage and use for native vegetation restoration, 3 April 2013 and translocation of threatened plants, 4 – 5 April 2013.

Next week the ANPC will be involved in workshops and symposia at the Society for Ecological Restoration Australasia Conference in Perth. We will participate in *The Australian Seed Bank Partnership*, and the *Seed sourcing guidelines for restoration success* symposia. We will be running a symposium on *The role of plant translocations in restoring and maintaining biodiversity: policy, planning and practice* with presentations by Tricia Hogbin and Leonie Monks. The ANPC has also been asked to participate in the workshop *Optimising our collective efforts: Australian environmental NGO networking meeting*.

Finally an important part of the coming year will be the development of a new Strategic Plan. The 2012 conference workshop *ANPC's future directions – where to from here* provided an ideal opportunity for us to consider a range of issues that should contribute to the development of a Strategic Plan. It is hoped that the outcomes of this workshop will be collated and presented to first the Committee Meeting in 2013 and provide the impetus for the development of the Strategic Plan in 2013. Our goal will be to involve a large section of the ANPC membership and I hope that as members you will be prepared to participate in the drafting of what will be an important initiative for the future of the ANPC.

## ANPC's 9th National Conference

Mark Richardson

Email: [mrichardson.consultant@yahoo.com.au](mailto:mrichardson.consultant@yahoo.com.au)

The ANPC's 9th National Conference, entitled *Plant Conservation in Australia: Achievements and Future Directions* was held in Canberra from the 29 October to the 2 November 2012. It was attended by 120 participants.

An important aspect of the conference was that it was also celebrating the ANPC's 21st Anniversary. In 1991, the Australian National Botanic Gardens acted to co-ordinate the *ex situ* conservation of rare and threatened plants by organising the conference *Protective Custody? Ex Situ*

*Plant Conservation in Australasia*. That conference had among its key outcomes the intention to encourage communication and networking so that the diverse range of groups involved in plant conservation can be better informed and coordinate their efforts. Out of this came a proposal for the establishment of the Australian Network for Plant Conservation and its initiation in the same year. While the initial focus of the ANPC was *ex situ* conservation, this rapidly evolved encompassing all



(left to right) ANPC celebrates 21 years! To celebrate ANPC's 21 years, Bob Makinson plants a gum tree as part of the 21 Gum Salute. Photos: Tricia Hogbin

aspects of plant conservation and in particular bridging the gap between *ex situ* and *in situ* conservation approaches. The ANPC's 1st National Conference was held in Hobart in 1993 and was entitled "Cultivating Conservation: Integrated Plant Conservation in Australia" moving away from the original *ex situ* focus. Since then eight National Conferences have been held covering a broad range of topics, with the 9th being the first conference back in Canberra since the establishment of the ANPC.

The celebration of the ANPC's 21st anniversary commenced at the welcome reception held at the Australian National Botanic Gardens on the evening before the conference. As a part of the reception, 21 ANPC founding members, past presidents, long term members and a number of others representing those who have made major contributions to the ANPC over the past 21 years, each planted a eucalypt seedling in the Eucalypt lawn of the Australian National Botanic Gardens.

The 9th National Conference reviewed plant conservation achievements in Australia over the last two decades and evaluated the strengths and weaknesses of our existing approaches to plant conservation. It highlighted major issues facing plant conservation in Australia and identified plant conservation directions in Australia for the coming decades. The primary themes for the conference were:

- threats
- conservation policy
- plant conservation strategies
- vegetation, soil and water context
- ecological restoration
- role of the NGO sector.

Day One of the Conference was a plenary session in which nine invited speakers from around Australia spoke on the six themes of the conference. The speakers included three of the ANPC's very long term contributors, namely, Prof. Henry Nix, Prof. Kingsley Dixon and Dr. Stephen Harris. A number of the plenary session speakers recognised the significance of climate disruption (change), a term coined



Life membership was awarded to ANPC's past Presidents (from left), Bob Makinson (2011-2007), Kingsley Dixon (1999 – 2003), Judy West (2003-2007), and Henry Nix as the Chair of the ANPC Advisory Committee (1992-1998).

by Professor Henry Nix, and the impact it will have on Australian flora in the coming decades. They emphasised the need for development of new innovative approaches in seed science, ecological restoration and habitat management. That evening the newly developed National Arboretum Canberra, invited conference participants to visit the arboretum and learn more about its plans for the future.

Day Two was the presentation of thirty submitted papers, again addressing the themes of the conference. The papers covered plant conservation in a broad range of habitats and were presented by researchers, managers and practitioners from across the country and again demonstrated the breadth of the ANPC's membership and relevance.

Day Three was the holding of a series of eight workshops which again provided a range of topics addressing several of the themes. The workshops included one which looked at the future directions for the ANPC. Some of the key recommendations coming from that workshop included:

- development and dissemination of seed sourcing guidelines and standards for ecological restoration for Australia

- the need to better facilitate the transfer of research outcomes for seed banking and seed sourcing protocols (provenance) from scientists to practitioners
- the provision of technical advice on the management of remnant bushland which needs to be better targeted to local communities and delivered at a regional scale
- the need for increased recognition among the broader Australian community of the inherent value, beauty, utility, diversity, and cultural value of Australia's unique flora

- the need to better sell the story of the work that many Australians are already undertaking to help protect and conserve Australia's unique flora.

Following the conference three very successful field trips were run in local grassland areas, up into the nearby Brindabella Ranges and to Kosciuszko National Park.

An important event of the conference was the conferring of life membership on the ANPC's past Presidents Bob Makinson (2011-2007), Judy West (2003-2007) and Kingsley Dixon (1999 – 2003), and Henry Nix as the Chair of the ANPC Advisory Committee (1992-1998).

## Efforts to enhance populations of the Wee Jasper Grevillea: Successes and failures

*John Briggs and Scott Seymour*

*NSW Office of Environment and Heritage, Queanbeyan, NSW Email: john.briggs@environment.nsw.gov.au*

### Introduction

The Wee Jasper Grevillea (*Grevillea iaspicula*) is a threatened plant species which is highly localised in south-east NSW. In 2011 the total population of this species was about 300 mature plants spread across four sites. As part of the recovery program for this species over the last decade the NSW Office of Environment and Heritage has undertaken small-scale enrichment planting of two natural sites of the Wee Jasper Grevillea.

### Enhancement planting at Lake Burrinjuck

#### Initial planting attempt

The first enhancement planting was into an area adjoining a natural population of 40 plants located on a steep rocky north-facing limestone bluff on the shores of Lake Burrinjuck, about 70 km directly north-west of Canberra. The site is more than a two hour drive from our office and can only be readily accessed by boat. A small (0.3 ha) area was fenced in 1996 to protect the population from browsing by domestic goats which were introduced to the private property at that time. The fence enclosed a larger area than that occupied by the Grevillea and it seemed this situation offered an opportunity to extend the distribution of the species on this site.

Cuttings were taken from several plants in the population in winter 1999 and a total of 21 individuals were propagated. These were planted in July 2000 into those parts of the site not occupied by the Grevilleas. Most of the plantings were doing well until December 2000, but these were not inspected again until the following March, when it was discovered that none of the plantings had survived the dry (but not unusual) conditions that were experienced over summer.



*Wee Jasper Grevillea flower. Photo: John Briggs*

#### Second planting attempt

Because of the small total population and threats to the species it was decided that another planting attempt should be made. Prior to this second attempt a drip irrigation system was installed to aid survival of the plantings through summer. Cuttings were taken in winter 2001 from 17 individuals within the natural population. Due to the slow growth of the potted plants, planting was delayed until November 2003 when 32 individuals were planted. The site was then visited every three weeks through the first summer to fill water tanks (by pumping from the adjoining lake) and water the plants. The watering was then discontinued after the first autumn on the assumption that the plants would be sufficiently established to survive future summers.

The plantings grew moderately well for first few years and as of December 2005 there were 25 plants surviving. The

plants were not then inspected again until autumn 2007, at which time it was discovered that the goats had breached the fence and had heavily browsed both the plantings and the natural population. The goats had also denuded the ground cover and caused significant soil erosion on the site.

The fence was repaired and it was hoped the browsed plants would recover. However, a prolonged drought which commenced soon after the start of the project continued, and at the next inspection in May 2009 only 10 of the 32 plantings were still alive. By February 2011 there were only three survivors. At this stage the project appeared to have been largely a failure.

In May 2012 the site was re-visited to check the fence was still intact and excluding the goats from the surviving natural population. To our delight, eight Wee Jasper Grevillea seedlings were found near a few of the now dead 2003 plantings. This is evidence that at least a few of the plantings were successful in producing some seed before they succumbed to the drought and goat browsing. The above average rainfall experienced since September 2010 has enabled this seed to germinate and successfully establish. The continuing good seasonal conditions since May 2012 may possibly also lead to the establishment of additional seedlings. These seedlings are exciting news, as it means the project has had a small measure of success. Only the test of time will reveal whether these seedlings are able to develop through to maturity and themselves contribute seed. If this does happen then the goal of achieving a self-sustaining population on the western side of the site may yet be met. We have some optimism that the natural seedlings may prove more robust than plants grown from cuttings. This is based on some recent translocation work with another endangered plant, the Tumut Grevillea, where we have observed that plants grown from seed are more robust and have had better capacity to withstand dry summer conditions than plantings grown from cuttings.

#### Enhancement planting at Wee Jasper

One of the Wee Jasper sites for this species consists of three small remnant patches on private land. Each of these sites was fenced in the late 1990s to prevent domestic stock damaging the Grevillea plants. In 2009 plants were raised from cuttings taken from 12 individuals scattered across all three patches. These were planted into the unoccupied parts of two of the fenced sites and also used to replace several *Grevillea rosmarinifolia* plants that were growing in the landholder's driveway. These were replaced because they were hybridising with the nearby Wee Jasper Grevilleas and threatened the species' integrity at this site.

Ten individuals were planted in August 2010 into one fenced area and at the same time the landowner also put 12 plants into their driveway. Another 12 individuals were planted into the second fenced area in October 2011. None of these plantings received follow-up watering, and they were only monitored annually. The area has received well



*Scott Seymour in 2009 recording one of the many deaths of the 2003 plantings of the Wee Jasper Grevillea at Lake Burrinjuck. Photo: John Briggs*

above average rainfall since these plantings, including unseasonably wet summers during 2010/11 and 2011/12. In contrast to the Lake Burrinjuck plantings, 21 of the 22 plantings were surviving in May 2012, as were 10 of the 12 driveway plantings.

#### Lessons learnt

Why did the Lake Burrinjuck plantings largely fail and what could have been done differently? Why have the Wee Jasper plantings done so much better? Perhaps we were just unlucky to have commenced the Lake Burrinjuck project at the start of a prolonged and severe drought and if the plantings had been done a few years earlier a much more successful outcome may have resulted. If the plantings and habitat had not had the added stress caused by the incursion of goats then would the survival rates have been higher? Did we simply try to establish the Grevilleas on a part of the site that was fundamentally unsuitable habitat and where the Grevillea perhaps never naturally occurred? No doubt the first two factors played a part. The answer to the last question may become clearer once the fate of the recently discovered seedlings is determined over the next few years.

More frequent visitation to the Lake Burrinjuck site would certainly have enabled us to detect the goat incursion and increasing drought stress much sooner than we did. This would have then allowed us to take appropriate action to repair the fence and re-commence watering before irreparable damage was done. Unfortunately other demands on our work time and the challenges of accessing the site made it difficult to spend the time required, particularly considering the seasonal conditions that developed over that period.

#### Acknowledgements

The authors thank all those who have assisted with this project: Eric Gruber – fencing of sites; Geoff Butler & Jamie Gould – propagating plants; Burrinjuck State Park – loan of the boat; NPWS Queanbeyan Area Staff – installing watering system & fence maintenance; I&H Cathles & N & B Slyney – landowners

# Kangaroo Island Nationally Threatened Plant Project: making a difference to Kangaroo Island's threatened flora

Michelle Haby and Heiri Klein

Department of Environment, Water and Natural Resources, Kangaroo Island, South Australia.

Email: [michelle.haby@sa.gov.au](mailto:michelle.haby@sa.gov.au), [heinrich.klein@sa.gov.au](mailto:heinrich.klein@sa.gov.au)

## Introduction

The Kangaroo Island Nationally Threatened Plant Project (the Project) began in 2002 to recover 15 nationally threatened plant species that occur on Kangaroo Island. In 2003 a recovery plan was written to highlight the issues that threaten the long-term survival of these species and to provide recommendations for their recovery (Taylor 2003). In the recovery plan, five species were identified as being most at risk of serious decline in numbers, mainly due to the highly fragmented state of the landscape in the Eastern Plains area of the island in which they occur. These species are *Olearia microdisca*, *Pomaderris halmaturina* ssp. *halmaturina*, *Beyeria subsecta*, *Leionema equestre* and *Spyridium eriocephalum* var. *glabrisepalum*.

A key recommendation of the threatened plant recovery plan was re-establishment of suitable habitat for these five endangered species. This promoted some initial habitat restoration activities in 2004 when 2.6 ha of land were planted with 6000 plants comprising around 20 native species. However, it was clear from the outset that the project urgently needed to develop innovative methods to restore habitat on a scale large enough to make a difference in the landscape. Larger areas and an increased diversity of plant species were needed in order to establish resilient and self-sustaining habitat capable of reversing the decline of threatened plants in the region and ultimately securing their future.

## Trials and lessons learnt

Between 2004 and 2006 the Project trialled several different methods in order to establish the most efficient and effective means of achieving landscape-scale habitat restoration. These trials highlighted four key impediments to success:

- grazing impacts from native herbivores
- competition from weeds and pasture grasses
- insufficient knowledge of propagation techniques
- limitations in engaging enough community volunteers to plant large numbers of seedlings.

As a result of continuous trials since 2004, these impediments to the delivery of landscape-scale habitat re-establishment in eastern Kangaroo Island have been largely overcome.

## Solution to the impact of grazers

Kangaroo Island (KI) has an abundance of native herbivores such as possums, wallabies and kangaroos that often have a detrimental impact on newly-planted seedlings. Conventional habitat re-establishment projects on KI typically relied on plastic guards to protect plants from grazing by native herbivores. This labour-intensive and costly technique was replaced with effective herbivore exclusion fencing.

## Solution to weed competition

Prior to European settlement, the Eastern Plains area of KI was largely covered by *Eucalyptus cneorifolia* woodland with dense shrubby understorey. This woodland was



(top to bottom) Scraped paddock ready for transplanting. Four years after the paddock was transplanted and direct seeded. Photos: Heiri Klein

cleared for agriculture by the early settlers and sown with a range of introduced pasture grasses. Early trial work demonstrated that these pasture grasses greatly reduced the survival and growth of planted and seeded native vegetation. By applying a combination of herbicide treatment methods, topsoil removal and dense plantings of tubestock, a substantial reduction in weed competition was achieved. As a result, direct seeding success and long-term native plant survival have been greatly improved.

### Solutions to propagation challenges

Surveys conducted have shown that there are in excess of 300 native plant species growing in association with *Eucalyptus cneorifolia* on eastern KI. This woodland has a highly diverse understorey of native grasses, forbs and small shrubs (ie *Lasiopetalum* and *Daviesia*) as well as mid-storey (i.e. *Acacia* and *Melaleuca*) species.

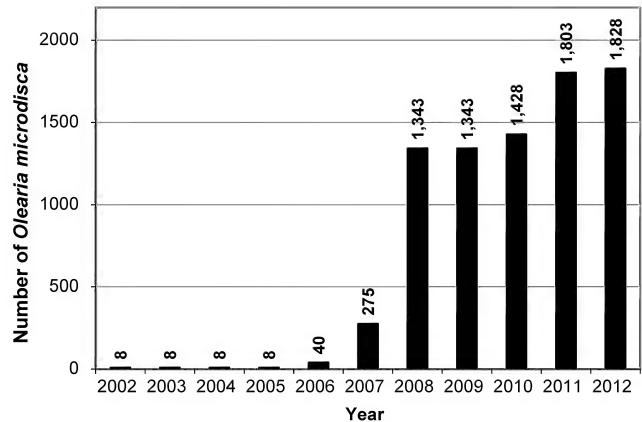
Propagation techniques for this diverse range of native plants, including the nationally threatened species, were poorly developed. Continuous propagation trials have been conducted to improve understanding of the specific requirements of each of the target species. Accordingly, the Project now has the capacity to propagate over 130 native plant species and has established highly successful methods for germination of the nationally threatened *Olearia microdisca* and *Pomaderris halmaturina* ssp. *halmaturina*. This has had the outcome of successfully increasing one subpopulation of *Olearia microdisca* from eight plants in 2006 to 1828 in 2012. Some success has also been achieved with the remaining three threatened species, but more trial work will be required to 'crack their code'.

Along with propagating and planting tubestock, the Project also direct seeds habitat restoration sites. Seed pre-treatment methods needed to be refined to ensure *in situ* germination of sown seed. The number of species that are direct seeded has steadily grown over the years and is now around forty.

### KI Planting Festival – the solution to engaging large numbers of volunteers

Large-scale habitat re-establishment would be difficult to achieve using the conventional approach of engaging a small group of staff and local volunteers to undertake planting. Kangaroo Island's small population has meant that the Project needed to look further afield and engage volunteer planters from the mainland. Accordingly, the KI Planting Festival was developed as a multi-day volunteer planting event to facilitate the planting of the high number of plants required for large-scale habitat re-establishment.

The Festival was first trialled in 2007 when 60 volunteers planted over 15 000 seedlings distributed over 15 ha in three days. Continual refinement of the festival such as on-going improvements in logistics, infrastructure and marketing has led to a growth in popularity of this event amongst island and mainland volunteers. Today, the



Population estimate for *Olearia microdisca* sub-population (F) Playford Highway within a 300 ha area

Project engages 300–800 volunteers annually, mostly through the KI Planting Festival, allowing large areas of land to be planted efficiently and effectively with dense (approximately 2500 plants per ha) and diverse (130+ species) plantings.

### The future

The Project aims to create more resilient and self-sustaining habitat for KI's most threatened plant species by maintaining a continued focus on creating maximum diversity in dense, large-scale plantings. Remnant vegetation patches within the highly fragmented landscape of eastern Kangaroo Island will thus be reconnected and buffered through a series of large-scale biodiverse plantings. One of the project's key short-term objectives will be to improve the understanding of the propagation requirements for the remainder of Kangaroo Island's Nationally Threatened Plant Species.

### Conclusion

To date, the Project has restored 220 ha of degraded land using approximately 450 000 tubestock on seven separate properties within the Eastern Plains area of Kangaroo Island, thereby creating large pockets of critical habitat for Kangaroo Island's nationally threatened plant species. At Cygnet Park Sanctuary, one of the restoration sites, nearly 180 ha have been restored. As a result, this site now contains the largest patch of native vegetation in the Eastern Plains area of Kangaroo Island and, perhaps more importantly, has become the largest, continuous area of occupancy for *Olearia microdisca* and *Pomaderris halmaturina* ssp. *halmaturina*.

The restoration efforts undertaken have resulted in highly diverse and dense plantings that include over 130 species representing all vegetation strata. Along the way, a great deal of valuable knowledge about native plant propagation techniques have been gained that can be applied on Kangaroo Island and elsewhere to improve biodiversity and resilience outcomes in habitat restoration programs.

### Partners

Project work supported by: Kangaroo Island Natural Resources Management Board, Australian Government's Caring for our Country program, Bio-R, Conservation Volunteers Australia, Government of South Australia, NatureLinks, Native Vegetation Council, Natural Heritage Trust, Threatened Plant Action Group, UniLife, University of Adelaide and World Wildlife Fund.

### References

Taylor, D.A. (2003). *Recovery Plan for 15 Nationally Threatened Plant Species on Kangaroo Island, South Australia*. Report to the Threatened Species and Communities Section, Department for the Environment and Heritage

# *Euphrasia arguta*: management of a species previously presumed extinct

Doug Binns

Forests NSW, Coffs Harbour, NSW. Email: [doughb@sf.nsw.gov.au](mailto:doughb@sf.nsw.gov.au)

### *Euphrasia* ecology

The genus *Euphrasia* is globally distributed in temperate regions. All species are assumed to be semi-parasites but this aspect of the ecology has not been studied in Australia and details, including whether this is obligate parasitism, are unknown for Australian species. Most of the ecological knowledge of Australian species is due to Potts (1997), working on Tasmanian species. *Euphrasia* species are thought to develop long-lived soil seed banks (perhaps several decades or more), but for Australian species data are lacking and the evidence is circumstantial. Many species are annuals or short-lived perennials which appear to need open space with low or sparse ground cover, or disturbance which creates these features, for successful recruitment. Seeds are generally poorly-dispersed and many populations are extremely local.

### Rediscovery of *Euphrasia arguta*

In Australia, the genus *Euphrasia* contains a disproportionately high number of threatened species. Until its recent rediscovery, *Euphrasia arguta* was one of two NSW species presumed extinct. It was rediscovered in April 2008 in Nundle State Forest east of Nundle, on the northern tablelands, by Forests NSW ecology field worker Graham Marshall. Prior to this, it had not been recorded since 1904. Between the first collection in approximately 1804 and the collection from Nundle in 1904, there were few records from widely separated localities (e.g. Bathurst, Mudgee, Blue Mountains and 'Hunter's River') (Barker 1987). On that basis, *E. arguta* has suffered a drastic contraction in range over the last two centuries.

*Euphrasia arguta* was rediscovered in an area of forest which was cleared for a fire break 15 months earlier in January 2007. The cleared fire break was a strip about 10-20 m wide from which all above-ground vegetation had

been removed. Approximately 80 plants were counted in the fire break and no plants were seen in the adjacent uncleared forest. Although it may have been present in the area prior to clearing, the occurrence of the plants only in the cleared area suggests that it had recruited following clearing. When assessed again 9 months later, in January 2009, the population had increased greatly and was estimated to comprise approximately 20 000 plants in an area of about 0.7 ha. The density was extremely variable, from 0.01 to 230 plants per m<sup>2</sup>, with patches of highest density in areas of open ground cover. A few plants were found in adjacent forest, but the highest density by far, comprising 99.8% of the population, was in the cleared area.

In early December 2009, about half the extent of the population, comprising about 80% of the plants, was mistakenly cleared again, removing vegetation and scraping most of the soil surface. This further clearing was done during emergency fire control activities. Even though planning controls were in place for protecting the population, plans and threatened plant records tend to be overlooked during fire control emergencies. This may have been avoidable by the use of permanent on-site signs indicating the occurrence of significant species, but signs may draw unwanted attention to the exact location of sensitive species and their use requires careful consideration of all the risks involved.

### Population changes

Observations over the last few years indicate that *E. arguta* is an annual, with peak flowering and fruiting between January and April. Some plants persist well into July and it is possible that some plants may survive for more than one season under favourable conditions. Germination occurs mainly during November to December, coinciding with the period of long-term maximum monthly rainfall for the area. The second clearing event occurred during

a critical time for the species, after most of the current season's cohort had germinated but before any seed was set. As a result, it was expected that the population would be severely depleted. In February 2010, no new germination had occurred in the recently cleared area and the population of live plants in that area consisted entirely of very small patches (each no more than a few tens of square centimetres) in small depressions which had been below the general level of soil scraping and had survived the second clearing. No quantitative assessment was done in 2010, but it was estimated that the population in early 2010 was less than 5000 plants, mostly (approximately 90%) in the area which was cleared only once, in 2007.

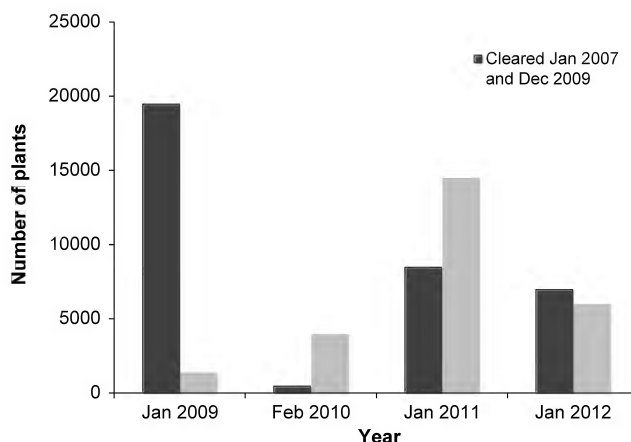
Further assessments were conducted in January 2011 and January 2012. The population in the twice-cleared area had increased to a greater extent than expected by 2011. The pattern of distribution of plants suggested that either dispersal is greater than thought, or that part of the seed store remained dormant following the initial clearing. If the latter is the case, the lack of germination response immediately after the December 2009 clearing may have been due to the absence of germination cues, such as adequate rainfall or changes in day length, at that time. The population showed evidence of decline between 2011 and 2012, which coincides with increasing density and height of surrounding vegetation.

Areas near the population, in which no standing plants of *E. arguta* had been observed during previous surveys, were subject to timber harvesting, including substantial soil disturbance, during 2011. Subsequently, plants have been observed in the harvested area, outside the previous boundary of the population. It is unknown whether these plants originated from soil-stored seed or from seed dispersed to these areas.

### Management

Species, such as those of the genus *Euphrasia*, which appear to require appropriate active disturbance regimes for recruitment and maintenance of populations, raise some significant management questions. Is it preferable to rely on the persistence of soil-stored seed and the likelihood that an appropriate disturbance (such as fire) will occur by chance over a period of several decades? Or should an attempt be made to maintain populations of standing plants at some minimum threshold size and ensure continuing accessions to the seed bank? Considering that the longevity of soil seed stores is uncertain for Australian *Euphrasia* species generally, unknown for *E. arguta* specifically, and cannot be determined in the short term, reliance on long-term soil-stored seed seems a risky management strategy. Since germination cues and recruitment requirements are also uncertain, it is preferable that at least part of the population is seasonally maintained as standing plants.

In the last few years, a few other populations of *E. arguta* have been found in nearby areas of Nundle SF and adjacent private property, so the overall risks to the species



Changes in size of *Euphrasia arguta* population in Nundle State Forest.



Flowers of *Euphrasia arguta*, Nundle State Forest.  
Photo: Doug Binns

are diminished to some extent. However, the firebreak population remains the largest, comprising 90% of the total number of known plants in 2012. It is intended that the population continues to be monitored annually. If the population size declines substantially, as height and density of surrounding vegetation increases, small parts of the population will be subject to clearing of ground vegetation during spring, using either mechanical clearing or burning, as opportunity permits. Observations on the population changes following these actions will be used to guide subsequent management.

### References

- Barker, W.R. (1987) Taxonomic studies in *Euphrasia* L. (Scrophulariaceae). V. New and rediscovered taxa, typifications and other notes on the genus in Australia. *Journal of the Adelaide Botanic Gardens* 10:201-221.
- Potts, W.C. (1997) *Recovery Plan for Threatened Tasmanian Lowland Euphrasia species 1997-2001*. Department of Primary Industries, Water and Environment, Hobart. Available online from <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/tas-euphrasia/index.html>.

# Victorian Orchid Conservation

Noushka Reiter<sup>3\*</sup>, Richard Thomson<sup>2</sup>, Neil Anderton<sup>2</sup>, Wendy Bedggood<sup>1</sup>, Chris Jenek<sup>2</sup>, Rob Cross<sup>2</sup>, Julie Whitfield<sup>1</sup>, Ann Lawrie<sup>4</sup>,  
Gail Pollard<sup>2</sup>, Mary Argall<sup>4</sup>, Glen Johnson<sup>1</sup> and Karen Lester<sup>1</sup>

<sup>1</sup> Department of Sustainability and Environment, Victoria; <sup>2</sup> Royal Botanic Gardens Melbourne, Victoria; <sup>3</sup> Wimmera Catchment Management Authority, Horsham, Victoria; <sup>4</sup> RMIT University, Melbourne, Victoria; \*Corresponding author email: reitern@wcma.vic.gov.au

## Introduction

Victoria is home to almost 400 predominately terrestrial orchids of which at least half are considered threatened. State and Federal Governments have legislated to protect threatened flora through State Action Statements under the *Flora and Fauna Guarantee Act 1998* (FFG Act) and National Recovery Plans under the *Environment Protection and Biodiversity Conservation Act 1999*.

Australian orchids form a web of interdependence between mycorrhizal fungi, pollinators, and the surrounding vegetation. To conduct successful reintroductions an understanding of all these interdependent processes is required. The importance of an integrated approach to conserving south eastern Australia's threatened orchids was recognised in Victoria by the early 1990s. The Threatened Orchid Recovery Team (TORT) formed around this time and eventually consisted of many organisations including the Royal Botanic Gardens Melbourne (RBGM), Melbourne Zoo, Melbourne University, Victoria University, RMIT University, local governments, Catchment Management Authorities (CMA), the Department of Sustainability and Environment (DSE) and 40 community groups.

A backbone to the program is the ongoing enthusiasm of community groups which provide consistency through government funding cycles. The Australasian Native Orchid Society (ANOS) which formed 35 years ago; with the three main aims of growing, photographing and conserving orchids; take part in all aspects of the program in Victoria. ANOS have been directly involved with the reintroduction of at least 12 species of orchid in Victoria in the last six years.

Research is the key to conducting successful orchid conservation projects within Victoria. The RBGM in conjunction with several Universities and DSE has hosted many postgraduate projects on orchid conservation (Marvern, 1996; Wright 2007; Smith *et al* 2007). Recently collaborations between Melbourne University, RMIT University, the Wimmera CMA (WCMA) and the RBGM have explored taxonomic relationships of some of the orchid mycorrhiza.

## Reintroductions

This paper highlights five of many reintroductions, from the first official reintroduction in 2005 to the most recent in 2012, each reintroduction increasing our knowledge of orchid ecology and conservation.

## Wedge Diuris (*Diuris dendrobiodes*)

The Wedge Diuris was introduced in 2005 in the north-eastern part of Victoria near Wodonga in a native grassland reserve. The plants were propagated at Western Orchids in 2003 in media without mycorrhiza. In 2004 the germinating flasks were transferred to the RBGM where the researchers planted the orchids into local potting mix with the addition of site specific soil from the translocations site.

In 2005, 96 seedlings were planted into grids throughout the reserve with the aim of discovering habitat preferences for the species. Plants were not watered during the midst of a decade long drought. Approximately 50% of plants from the first year survived. The first flowering of tube stock were recorded in 2008 with natural pod production in 2010.

Natural recruitment through seed set is yet to be recorded. Asexual reproduction of daughter orchids has occurred at rates consistent with that of the natural population. The introduction was in conjunction with key management actions including ecological burning of the grasslands to manage biomass, environmental weed control pre and post burning, revegetation and monitoring of key fauna and flora species. This project identified key habitat traits associated with increased translocation survivorship including naturally draining soils, low biomass competition at establishment, and highlighted the need for additional watering of plants beyond planting.

## Yellow-lip Spider-orchid (*Caladenia xanthochila*)

The Yellow-lip Spider-orchid is a nationally endangered, striking-yellow plant which was once found in South Australia and Victoria. Now only 1000 plants remain in Victoria. Recovery efforts have discovered that this plant uses sexual deception to attract a thynnine wasp pollinator (Bower, 2007). The site for reintroduction was subsequently baited for the pollinator. One hundred and eighty plants grown with their symbiotic mycorrhizal partner were cultivated at the RBGM in 2005 and reintroduced into two sites in western Victoria in 2007. Both sites were fenced. Survival rate was approximately 60% and natural pollination and seed set has been recorded at both sites though no recruitment has taken place. Monitoring is ongoing as are threats associated with the reintroductions including weeds and disturbance by visitors, an important lesson learnt in site selection. A further reintroduction of 1000 plants grown at the WCMA is planned for June 2013, which can make use of this information.

### Sunshine Diuris (*Diuris fragrantissima*)

There is one remaining natural population of 31 plants of Sunshine Diuris in Melbourne in a small remnant patch of grassland surrounded by housing and industry which is continually under threat from weeds. This species is believed to be pollinated by a small native bee. Several Sunshine Diuris reintroductions were conducted within the Port Phillip Region of Victoria by DSE with Parks Victoria, ANOS and local government. A major reintroduction trial of 700 plants was conducted as part of a PhD (Smith et al 2007), which focused on why previous reintroductions of the species were apparently unsuccessful.

Information gained through the analysis of the data included; no benefits from adding additional mycorrhizal fungi to the soil, dormant tubers were less successful at establishing than non-dormant plants, a minimum tuber weight of 2 grams and adding organic matter to the site also improved plant survival. This information has then been used to inform subsequent reintroductions. The WCMA is currently propagating 3000 Sunshine Diuris for future reintroduction. Monitoring, watering in dry periods and weed management continue while an exploratory excavation is planned for 2013 to distinguish between tuber dormancy and death.

### Red Cross Spider-orchid (*Caladenia cruciformis*)

There are thought to be only 1500 Red Cross Spider-orchids in a small area in north central Victoria, it is listed under the FFG Act. The objective of this reintroduction was to establish two new populations on public land. Symbiotic propagation of this species commenced at the RBGM in 2005. Significant thought was put into site selection, experimental layout and mitigating threats including regular supplementary watering when required. Two consecutive plantings of 320 plants were conducted over two sites with an average of 76% survival for 2007 reintroductions and 83% for 2008 reintroductions.



Reintroduced Red Cross Spider-orchid recruited well with natural pollination and seed set observed. Photo: Noushka Reiter

Important information was gained through the experimental approach. This included the finding that there are no differences in survival from orchid spacing (whether 5 or 10 cm apart) or if plants are grown in Hyko cells or forestry tubes. Even very small plants were found to survive reintroduction which is more cost effective than returning them to the nursery. The reintroductions in 2007 and 2008 both recruited well in 2010 with a total of 197 additional plants recruiting in the two reintroduction sites after natural pollination and seed set were observed. Monitoring continues on both sites which are on the way to be considered successful reintroductions and self-sustaining populations for this species.

### Metallic Sun-orchid (*Thelymitra epipactoides*)

The Metallic Sun-orchid, now nationally endangered, was once considered common and widespread throughout south-eastern Australia. There are thought to be less than 1,500 Metallic Sun-orchids remaining. Through a project funded through the Australian Orchid Foundation 3000 Metallic Sun-orchids were grown and research on growing conditions and fungal phylogenetics were undertaken at the WCMA in conjunction with partners at RBGM and RMIT University. Information on the range of fungi to reintroduce were gained and subsequently used in the reintroductions.



Metallic Sun-orchids were reintroduced in May- July 2012 into three sites in Victoria. Photo: Noushka Reiter

Three sites for reintroduction were chosen within Victoria: one was adjacent to an existing site that was in decline, another in similar habitat to a site which had now become extinct and a third was within vegetation that was similar to the last remaining strongholds for the species within south-west Victoria. Through the WCMA and ANOS half these plants were reintroduced in May-July 2012, fenced or guarded, weeded and installed with dripper systems and tanks as required. Monitoring at each of the sites has been established.

### Knowledge gained

The success of the Victorian Orchid Conservation Program is reflected in the scientific papers published and presented at conferences and, importantly, the successful introduction of many ex situ propagated plants of threatened species. These achievements arise from the dedication and collaboration of people and organisations from different fields with complementary knowledge and resources.

### References

- Bower, C.C. (2007). Pollinators of threatened sexually deceptive Spider Orchids (*Caladenia* subgenus *Calonema*) in south western Victoria. Report to the Australian Orchid Foundation.
- Clements, M.A., Tupac, O. J., Miller, J. T. (2011). Phylogenetic relationships in Pterostylidinae (Cranichideae: Orchidaceae): combined evidence from nuclear ribosomal and plastid DNA sequences. *Australian Journal of Botany* 59, 99–117.
- Marven, G. (Honours) (1996). Photoautotrophic micropropagation of *Caladenia tentaculata* Schltdl. (Orchidaceae).
- Smith, Z. F., James, E. A., McLean, C. B. (2007). Experimental reintroduction of the threatened terrestrial orchid *Diuris fragrantissima*. *Lankesteriana* 7, 377–380.
- Wright, M. (PhD) (2007). Maximising the effectiveness of mycorrhizal fungi in the conservation of *Caladenia* taxa (Orchidaceae).

# Sowing seeds: bridging the gap between ex situ collections and reintroduction

Lydia Guja<sup>1,2,\*</sup>, Tom North<sup>1</sup>, David Taylor<sup>1</sup>, Joe McAuliffe<sup>1</sup>

<sup>1</sup> Australian National Botanic Gardens, Canberra, ACT; <sup>2</sup> Centre for Australian National Biodiversity Research, Canberra, ACT;

\* Corresponding author email: Lydia.Guja@environment.gov.au

### Introduction

Seed banks provide an efficient means of ex situ conservation for a wide range of Australian native plants. The Australian National Botanic Gardens (ANBG) holds a large collection of native species in its conservation seed bank, and is playing a crucial role in holistic conservation projects. A key to successful reintroduction is an understanding of how an ex situ collection can be utilised to bridge the gap between the 'freezer' and a self sustaining plant population in the wild. This article aims to demonstrate that for each seed collection the options for use are dependent on the size, quality, and genetic diversity of the collection. We outline the actions required to achieve successful collection, storage and germination of seeds, propagation of plant material, and reintroduction or translocation of rare or threatened species. The role of the seed bank in integrated conservation management is highlighted and key lessons learned for the future are outlined.

### Seed collections

A conservation seed bank consisting of quality collections is a strong foundation that can be utilised to achieve a number of conservation, management, and research outcomes. A good collection consists of:

- records such as herbarium vouchers, geographic location, habitat type, and collection method associated with each accession
- sampling in a random and even manner so that every plant has an equal chance of selection
- genetic diversity maximised by sampling multiple parent plants (30-50) per population
- quality ensured by collecting only viable, mature seeds
- sustainability considered and only 10-20% of available seed collected
- optimised utility through collection of more than 10 000 viable seeds per collection.

## Options for use

### Small collection (1 - 499 seeds)

Very few options for conservation management are provided by small seed collections. A small collection limits the ability to:

- conduct quality tests
- develop germination protocols
- re-test germination after storage
- research seed biology
- propagate plants.

Actions to increase the size and improve utility of a small collection include:

- targeting more populations
- alternative methods of sourcing seed
- successive annual collections.

### Minimal Collection (500 - 999 seeds)

Minimal seed collections provide limited options for conservation management and, therefore, limit the ability to:

- establish effective germination protocols if the seeds have complex dormancy syndromes
- propagate an adequate number of plants for translocation
- provide alternative seed sources such as the establishment of seed production areas to increase seed availability.

Actions to increase the size and improve utility of a minimal collection are as for 'Small Collection (1-499 seeds)'.

### Satisfactory collection (1000 - 9999 seeds)

A seed collection of satisfactory size provides some options for conservation management and research. A satisfactory collection allows:

- quality tests and germination re-testing
- some limited research into seed biology and ecology
- propagation of approximately a third of the collection.

A satisfactory collection may still restrict options for use and can limit the ability to:

- research complex dormancy syndromes and develop germination protocols
- propagate an adequate number of plants for translocation.

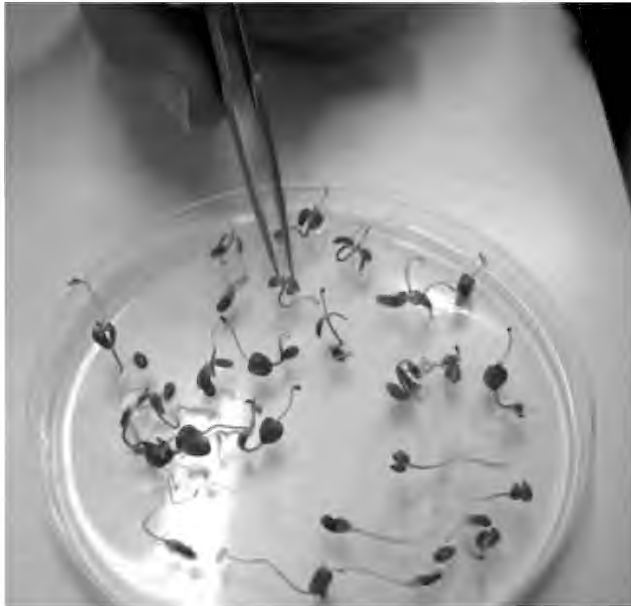
Actions to increase the size and improve utility of a satisfactory collection are as for 'Small Collection (1-499 seeds)'.



*Small collection (1 - 499 seeds) case study: Mountain Cress (Drabastrum alpestre) occurs in three states in south-eastern Australia. In the Australian Capital Territory (ACT) it is known from only one location of c. 600 plants. The ACT Government and the ANBG are collecting, storing, and developing germination protocols for seeds of this threatened species. During the 2011/12 summer 80 seeds were collected. Future collections will increase conservation and recovery options. Photo: Colin Schofield ACT Parks and Conservation.*



*Minimal collection (500 – 999 seeds) case study: Ginninderra Peppergrass (Lepidium ginninderrense) is threatened with only c. 406 plants remaining in the wild. The Seed Bank at the ANBG currently holds c. 950 seeds, separated by maternal line, representing the genetic diversity of the species. Propagation methods optimised at ANBG's nursery ensure the best chance of reintroduction success. Translocation is planned with the New South Wales Office of Environment and Heritage. Photo: Joe McAuliffe ANBG.*



*Satisfactory collection (1000 – 9999) case study: Native Flax (Linum marginale) foundation seedlings ready for transfer to seed production areas (SPAs). The ANBG, Centre for Australian National Biodiversity Research (CANBR) and Greening Australia are collaborating, funded by the Caring for our Country program, to improve availability of seed for diverse restoration of threatened grasslands using SPAs.*

*SPAs help minimise impacts of continued collecting on remnant vegetation, provide opportunity to research genetic implications of SPAs, and supply seed for restoration.*

*Photo: Tom North ANBG.*

#### **Optimal collection (more than 10 000 seeds)**

An optimal collection is ideal for conservation management and research. A collection of 10000 or more seeds per species allows:

- splitting of the collection into conservation (long term storage), active (short term storage for e.g. research or propagation), and duplicate collections (to mitigate against loss);
- germination re-testing to monitor the effect of storage on seed survival and vigour
- assessment of alternative storage methods if required
- research into complex seed dormancy and development of germination protocols
- optimisation of propagation methods
- reintroduction of adequate numbers of plants.

Although a collection may be of optimal size it is still important to consider further actions that may be taken. Further actions can ensure that a collection is representative of a species, and that the germination requirements of the species can be met. Actions that can be taken to improve optimal collections include:

- targeting more populations and parent plants to represent the range and genetic diversity of a species
- identifying, collecting, and storing other materials that may be required for germination or establishment e.g.

mycorrhizal fungi for orchids or seeds of host plants for parasitic species.

#### **Planning**

Planning is key to optimal seed collections and reintroductions. For every collection it is important to:

- identify the purpose of the collection e.g. conservation, restoration or research
- plan to make conservation collections before only a few plants remain in the wild and only a few seeds can be collected or collection impacts the viability of the wild population
- research the target species (ecology, biology, taxonomy and flowering and fruiting phenology) to inform collection and propagation procedures
- plan for associated research e.g. recalcitrance, complex dormancy, or symbiotic relationships
- monitor and evaluate conservation or restoration in the long term
- communicate results and lessons learned to inform future actions.



*Optimal collection (more than 10 000 seeds) case study: Brindabella Midge Orchid (Corunastylis ectopa) inflorescence.*

*The ANBG, CANBR and ACT Government are collecting, storing, and developing germination protocols for seeds of three threatened ACT orchids. Orchids have high fecundity making collection targets achievable. However, seed germination relies on association with specific mycorrhizal fungi which must also be collected and stored. The project aim is future reintroduction and translocation.*

*Photo: Mark Clements ANBG & CANBR.*

### Bridging the gap

Key lessons learned from collaborative projects aimed at bridging the gap between the 'freezer' and a self sustaining plant population in the wild are:

- an ideal collection that provides options for conservation, reintroduction and research is 10 000 seeds or more, collected from multiple populations to represent the range and genetic diversity of a species
- the impact of wild seed collection on remnant populations may be reduced by using foundation collections from the wild to establish seed production areas and increase seed availability
- refining germination protocols and horticultural techniques at the outset will help determine the best method, and increase success, of reintroduction

- improved knowledge of the biology, ecology, and genetics of a species is required to guide further research and activities aiming to restore viable plant populations.

### Further reading

Offord, C. A. and Meagher, P. F. (Eds.). (2009). *Plant Germplasm Conservation in Australia. Strategies and Guidelines for Developing, Managing and Utilising Ex Situ Collections*. Australian Network for Plant Conservation Inc., Canberra.

Smith, R. D., Dickie, J.B., Linington, S.H., Pritchard, H.W. and Probert, R.J. (Eds.). (2003). *Seed Conservation: Turning Science into Practice*. The Royal Botanic Gardens Kew, Great Britain.

### Acknowledgements

Many people are involved in these conservation projects and their contributions are greatly appreciated.

# Seeds behaving badly: Conservation of rainforest species

*Graeme Errington, Peter Cuneo and Catherine A. Offord*

*Royal Botanic Gardens & Domain Trust, Sydney. Email: [graeme.errington@rbgsyd.nsw.gov.au](mailto:graeme.errington@rbgsyd.nsw.gov.au)*

The aim of Rainforest Seed Conservation Program of the Royal Botanic Gardens & Domain Trust is to identify species that can be seed banked and those with 'bad' seed storage behaviour that require alternative ex situ germplasm conservation techniques. The exploration of the seed storage behaviour of seeds can be complicated and there is much to learn about how seeds from rainforests respond to seed storage treatments and how we should approach alternatives for germplasm conservation.

### Rainforests

Rainforests are important repositories of biodiversity that contain many threatened species of flora and fauna. Across the planet, rainforests also have important economic and cultural values. In NSW, rainforests cover less than 1% of the land area with around 30% of the pre-European extent lost. Many of the remaining remnants have been subjected to logging during past management. Some rainforest communities have been dramatically changed, with remnants occurring as small fragmented areas that are infested with invasive species and diseases such as the recently arrived fungus myrtle rust.

### Seed banking

Seed banking is an efficient and effective long-term ex situ conservation strategy for species that tolerate drying and storage at low temperature. Many rainforest species

have large, fleshy fruits - characteristics that are commonly associated with poor seed storage potential. To date, there is limited understanding of the seed storage behaviour of rainforest species and as a result, these species are under-represented in seed bank conservation programs. Highly successful programs like the Millennium Seed Bank Partnership have focussed on dryland flora, with good reason, as a high proportion of the species from plant communities in these areas are suited to seed banking. By comparison there has been relatively little work on seed storage of rainforest species globally or within Australia.

### Seed storage behaviour

Roberts (1973) described two classes of seed storage behaviour: orthodox and recalcitrant. Orthodox seeds have increased storage longevity in response to decreased seed moisture content and decreased storage temperature, with maximum longevity at conditions of low moisture content (2-6%) and at a temperature of -20° C. Internationally many seedbanks have used these parameters to develop seed storage facilities for crop and wild species. In Australia, dominant plant groups such as *Acacia* and *Eucalyptus* have orthodox seed and long-term conservation seed banks such as the NSW Seedbank have developed extensive collections of these and other dryland species.

The term recalcitrant is applied to seeds that do not tolerate drying. This type of seed cannot be dried below a

relatively high moisture content without a significant drop in viability (this 'critical moisture content' varies between species), consequently recalcitrant seeds are not suited to conservation seed banking. Terms such as desiccation tolerance and desiccation sensitivity have been applied to the response of seeds to moisture loss. Seeds that can be dried to low moisture contents, 4-7% are termed desiccation tolerant. Desiccation tolerance and dormancy are two plant traits that allow seeds to develop soil seedbanks and survive until suitable conditions for germination occur. Desiccation tolerant seeds can be dried and stored at -20° C which extends the period of viability, and as indicated previously, these types of seeds are termed orthodox.

There is an important distinction between desiccation tolerant and orthodox. Some desiccation tolerant species, such as some Australian *Citrus* spp. and *Macadamia ternifolia* (Hamilton, *et al.*, 2010), have high oil content and this oil has a phase transition at freezing temperature and has the potential to cause a loss of viability as a result of low temperature storage, thus are not classified as orthodox species.

Since the initial classification of seed storage behaviour by Roberts, it has become clear that a number of species cannot be accounted for by the two existing categories of seed storage behaviour. Ellis (1990) proposed a new classification of intermediate seed storage behaviour. This classification is indicative of a spectrum of desiccation tolerance and seed storage behaviour, Figure 1. Seeds of the intermediate category can be dried to around 10-12% moisture content, but they are sensitive to storage at sub-zero temperatures.

The categorisation of some species is complicated by unusual seed behaviour. In paw paw (*Carica papaya*), drying induces a dormancy that may result in seeds being classified as non-viable or desiccation sensitive in a germination test. This is further complicated by crystallisation of lipids at sub-zero temperatures, which then require exposure to high temperatures before germination can occur. In *Azadirachta indica*, slow drying

can allow seeds to be fully desiccation tolerant and stored at -18°C or less, but the seeds must imbibe moisture at high temperature (above 25°C), or they may suffer chilling damage (Kew, n.d.). These types of behaviours make it difficult to make general recommendations about the storage of intermediate species.

### Identifying seed storage behaviour

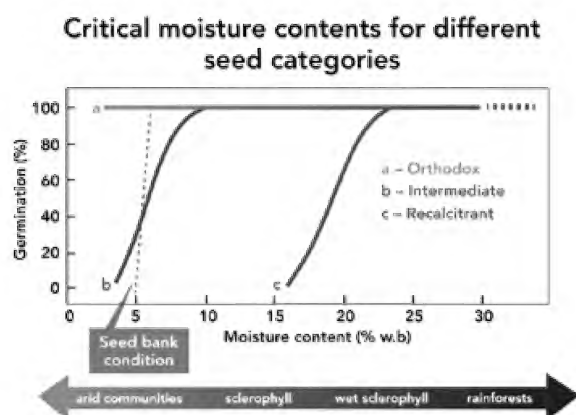
The main purpose of the Rainforest Seed Conservation Project is to identify orthodox species that can be seed-banked and to ensure they are adequately represented in our seed bank. Initially the desiccation tolerance of a species must be determined, and then further viability testing examines the response to storage at -20° C. There are a number of sources of existing information regarding seed storage behaviour, such as the Kew Seed Information Database and some general indicative characteristics that can be used to make assessments about potential seed storage behaviour:

- dry capsules and dehiscent fruits generally have desiccation tolerant seeds
- taxonomy – some families such as Dipterocarpaceae are almost exclusively recalcitrant but other families have a proportion of all seed storage behaviour categories e.g. Myrtaceae and Proteaceae
- wetter environments have a high proportion of recalcitrant species and drier environments have a high proportion of orthodox species (aquatic seeds are generally orthodox)
- seeds that are released during the wet season have a high proportion of recalcitrant species and seeds released during the dry season have a high proportion of orthodox species
- larger seeds tend to be recalcitrant
- seeds with very thin seed coats tend to be recalcitrant (determined by the seed coat ratio).

Our screening process compares seed germination response to three treatments: fresh seed, dried seed and moist seed (stored for the same time period as seed takes to dry) based on the 100 seeds test (Pritchard, *et al.*, 2004). If the germination rate in the dried seed treatment is similar to the fresh seed, then the species is considered to be desiccation tolerant. Germination is tested again after storage at -20° C.

### Strategies for desiccation intolerant seeds

The seeds of some recalcitrant species can be stored at low temperature: 0-5° C, for up to 12 months for temperate species and 16° C for 3-6 months for tropical species (Kew, n.d.). The response to these treatments can be variable; some species germinate if the temperature is too high, and other species may suffer chilling damage. Alternative germplasm conservation techniques such as tissue culture and cryostorage may be suitable strategies but protocols can be specific and difficult to develop.



Determination of seed storage classification e.g. orthodox seeds maintain viability when dried to 5% and stored at -20° C (seed bank condition). Adapted from (Kew, n.d.).

### Rainforest seed collection program

A key part of this seed conservation program is the collection of rainforest seed from wild locations. There are a number of advantages and disadvantages of seed collecting in rainforest habitats as opposed to dry-land communities. Asynchronous fruit ripening both within and between species offers a greater window of opportunity for collection across the year. This is an important factor when considering the need to process seed in a timely manner regarding potential viability loss during handling. A particular disadvantage is that some rainforest species exist as individuals spread across the landscape rather than closely clustered populations. This has implications

for the effort required in maximising the genetic diversity of collections.

A high priority for the program is the collection of species that are affected by myrtle rust. First detected in 2010, myrtle rust has spread from the central coast of NSW to Victoria and far north Queensland. The rust has had a dramatic effect on some Myrtaceae species, such as *Rhodamnia rubescens*, which suffer defoliation and reduced flower and seed production. This may have profound effects for the long-term survival of these species. The seed storage behaviour of *R. rubescens* and many other affected rainforest species is not yet known. Future collection trips will focus on collecting, assessing seed and where possible storing seed from these species.

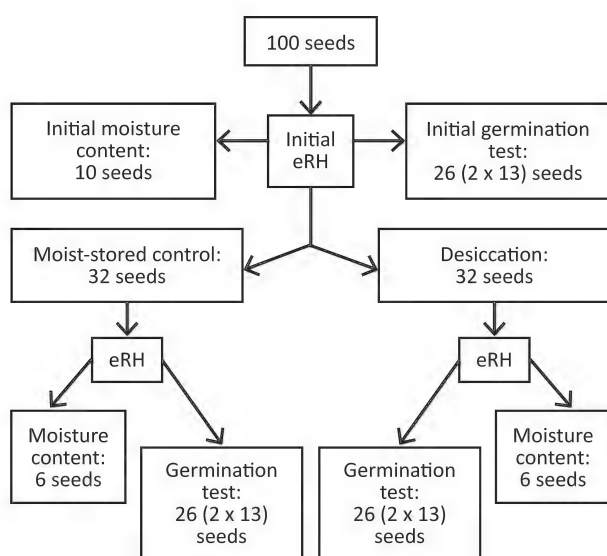


Diagram of 100 seed test for desiccation tolerance (Gold & Hay, 2008). Equilibrium relative humidity (eRH) is a non-destructive measurement of moisture content, actual moisture content is calculated using an oven-dry method.

### References

- Ellis, R. H., Hong, T. D., & Roberts, E. H. (1990). An intermediate category of seed storage behaviour? I. Coffee. *Journal of Experimental Botany*, 41, 1167-1174.
- Gold, K., & Hay, F. (2008). *Identifying desiccation-sensitive seeds - Technical Information Sheet No. 10*, Millenium Seed Bank Project. Kew: Royal Botanic Gardens.
- Hamilton, K. N., Offord, C. A., Cuneo, P., Ashmore, S. E., & Deseo, M. (2010). Conserving Australia's Unique Rainforest Fruits and Wild Relatives. Paper presented at the *International Horticultural Congress*, Lisbon.
- Kew (n.d.). *Seed Storage Behaviour - Difficult Seeds Project* [Electronic. Retrieved 20 November 2012, from <http://www.kew.org/science-research-data/kew-in-depth/difficult-seeds/resources/index.htm>
- Pritchard, H. W., Wood, C. B., Hodges, S., & Vautier, H. J. (2004). 100-seed test for desiccation tolerance and germination: a case study on eight tropical plant species. *Seed Science and Technology*, 32.
- Roberts, E. H. (1973). Predicting the storage life of seeds. *Seed Science and Technology*, 1, 499-514.

## The endemic flora of Norfolk Island: Conservation challenges on a remote oceanic island

Kevin Mills

Jamberoo, NSW. Email: [k.mills@bigpond.net.au](mailto:k.mills@bigpond.net.au)

### Introduction

Many islands throughout the world have suffered greatly from the arrival of humans and the inevitable introduction and naturalisation of exotic plants and animals. The viability of island endemic organisms is often severely compromised because of their small populations and inability to cope with competition and/or predation from

introduced organisms. This is particularly so for remote oceanic islands located far from the resources required for adequate conservation works.

Norfolk Island was settled by the English in 1788, soon after Port Jackson (Sydney); it has therefore been subject to over 220 years of change and alteration to its natural environment. The Norfolk Island Group is an

external Australian territory located 1500 km east of Australia, between New Caledonia and New Zealand. The territory is self-governing, but is also subject to various Commonwealth laws. The main conservation area on the island group is managed as Norfolk Island National Park by Parks Australia.

### The flora

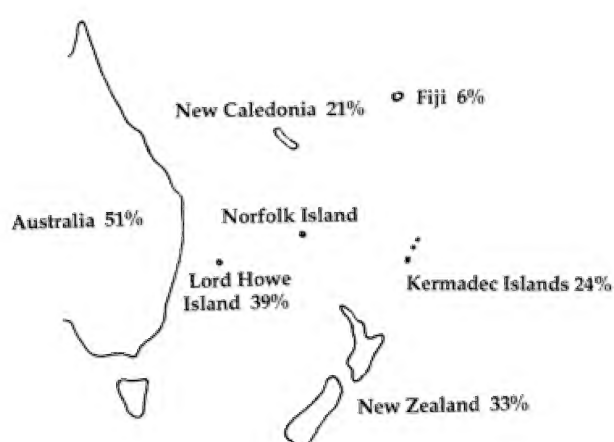
The total recognised indigenous flora of the Norfolk Island Group stands at 181 taxa. Eight species are known to have become extinct on the islands since 1788; two of which are extinct worldwide, while six occur in other places. Forty-three taxa or 24 percent of the indigenous taxa are endemic to the island group. A full list of the endemic and threatened taxa is provided by Mills (2009) in *Australasian Plant Conservation* 17(3).

The indigenous plants found on the islands are a reflection of the floras of the closest land masses: 51 percent shared with Australia, 33 percent with New Zealand, 21 percent with New Caledonia and 6 percent with Fiji. About 39 percent is shared with Lord Howe Island, the closest land mass, 900 kilometres to the southwest. The higher percentages for Australia and Lord Howe Island are because weather systems move eastwards; the likelihood of transport of propagules is therefore higher from that direction.

Naturalised taxa outnumber indigenous taxa by two to one. The 378 naturalised species come from most parts of the world, with strong representation of species from Australia, Europe and South America.

### Threatened plants

Plant taxa considered threatened in the early 2000s were placed on the schedules in the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. Of the 181 indigenous taxa, 46 (25%) are listed under the Act; most are woody plants. Forty-three species are endemic to the islands; 13 are not listed as threatened. The document *Norfolk Island Region: Threatened Species Recovery Plan* (Director of National Parks 2010) aims to address the threats to the listed species.



Location of Norfolk Island. Figures are percentages of Norfolk's indigenous taxa shared with nearby land masses.

Almost all of the listed taxa occur within the National Park, with other important occurrences on public reserves and private land. There have been no recent plant extinctions; in fact because of work by the islanders and Parks Australia in the past 20 years, several species have greatly increased in abundance. Some species have reappeared, including one assumed extinct and one new to science, following the eradication of Rabbits on Phillip Island in the 1980s.

### Threats

The threats to the indigenous flora of Norfolk Island are little different to elsewhere. The key threats are weed invasion, feral animals (particularly rats), lack of regeneration and climate change. These threats are compounded by the:

- very small size of the islands
- even smaller size of dedicated conservation areas
- dominance of weeds on much of the reserved land and across the islands
- pervading presence of the Black Rat, House Mouse and other introduced animals

Summary of the Norfolk Island Flora in terms of growth habit and status

| Plant Habit    | Indigenous (%) |               | Endemic   | Threatened | Naturalised (%) |               |
|----------------|----------------|---------------|-----------|------------|-----------------|---------------|
| Trees          | 31             | (17%)         | 13        | 15         | 37              | (10%)         |
| Shrubs         | 17             | (9%)          | 10        | 10         | 42              | (11%)         |
| Vines/Creepers | 19             | (10%)         | 3         | 3          | 17              | (5%)          |
| Forbs          | 31             | (17%)         | 5         | 5          | 209             | (55%)         |
| Grasses        | 15             | (8%)          | 0         | 1          | 55              | (15%)         |
| Orchids        | 11             | (6%)          |           | 4          | 4               | -             |
| Ferns          | 45             | (25%)         | 7         | 8          | 6               | (2%)          |
| Sedges/Rushes  | 12             | (7%)          | 1         | 0          | 12              | (3%)          |
| <b>Total</b>   | <b>181</b>     | <b>(100%)</b> | <b>43</b> | <b>46</b>  | <b>378</b>      | <b>(100%)</b> |

- changes in soil nutrients because of the destruction of petrel breeding colonies
- limited available budget
- small human population on the island.

Weeds and rats are the most pervasive and destructive to native plants and are addressed as a priority in the National Park. An extensive rat baiting network is established in the mainland section of the Park and Botanic Garden, containing about 1000 bait stations; operation of this network requires about 350 person-days per year.

Weed control in the Park is carried out systematically, based on 19 catchments; this ensures that part of each catchment is treated every year. About 10 hectares of new area within the 460 ha park area on Norfolk are treated each year; this involves about 750 person-days. Key weeds are *Ageratina riparia*, *Ipomoea cairica*, *Lantana camara*, *Olea europaea* ssp. *cuspidata*, *Psidium cattleianum*, *Schinus terebinthifolius*, and *Solanum mauritianum*.

### Conclusion

The conservation of the flora of the Norfolk Island Group, most particularly the endemic species, is challenging for several reasons. The islands are remote, there is a small human population, environmental degradation is high and pests and weeds are ubiquitous. Despite these challenges, the island community and the managers of the National Park have been successful in increasing the populations of most listed threatened species. Key activities include eradication of Rabbits from Phillip Island, propagation of most of the threatened species and their re-introduction to many parts of the islands, systematic weed removal from the National Park and localised weeding and planting within some public reserves by the Norfolk

Island Administration. Also of note is the work done in preserving the island's plants and animals by the Norfolk community and individual landowners.

A recent survey of the 31 endangered and critically endangered plant species occurring in the National Park found that some populations had increased greatly since surveys in 2003 (Mills 2012). Surveys by the author over six years found that of the 46 listed threatened species, 18 (39%) have obviously increased in abundance, 25 (54%) are probably stable while 3 (7%) have decreased in abundance. Some of those species despite being considered stable have very low populations and are of concern. The conservation work being carried out by Parks Australia is clearly beneficial to the populations of the threatened species in the park; some of the vulnerable species are now abundant in the Park.

While the results of recent surveys are encouraging, much work remains to be done. The commitment of those involved cannot be questioned; the key problem is finding the resources to carry out the conservation work. The development of island-wide approaches to some key issues is required; these issues include weed control, rat eradication and delineation of a habitat corridor system.

### References

- Director of National Parks (2010). *Norfolk Island Region: Threatened Species Recovery Plan*. Parks Australia, Canberra.
- Mills, K. (2009). Plant conservation on a remote oceanic island: the case of Norfolk Island. *Australasian Plant Conservation*, 17(3): 22-24.
- Mills, K. (2012). The Flora of Norfolk Island. 14. The Endangered Plants in the National Park: Field Survey and Review. The Author, Jamberoo, New South Wales, May.



*The endemic small tree Meryta latifolia (Araliaceae).*  
Photo: Kevin Mills



*Subtropical rainforest on Norfolk Island. Photo: Kevin Mills*

# Research and conservation initiatives for the vulnerable *Purple-wood Wattle*: a model for plant species conservation in Australia?

Andrew Denham<sup>1</sup>, Tony Auld<sup>1</sup>, David Ayre<sup>2</sup>, Cairo Forrest<sup>2</sup>, Amy Gilpin<sup>2</sup>, Eleanor O'Brien<sup>2</sup> and David Roberts<sup>2</sup>

<sup>1</sup> NSW Office of Environment and Heritage, Hurstville, NSW. Email: andrew.denham@environment.nsw.gov.au;

<sup>2</sup> Institute for Conservation Biology and Environmental Management, University of Wollongong.

Research on rare and threatened plants is a major focus of conservation biology. We want to know why species are rare or declining, how best to arrest that decline and what is lost when species become locally extinct. Occasionally, understanding decline is straightforward – e.g. if the species is restricted to fertile soils that are desirable for cultivation. However, managing declining populations is more complex and requires knowledge of genetic diversity and interspecific interactions.

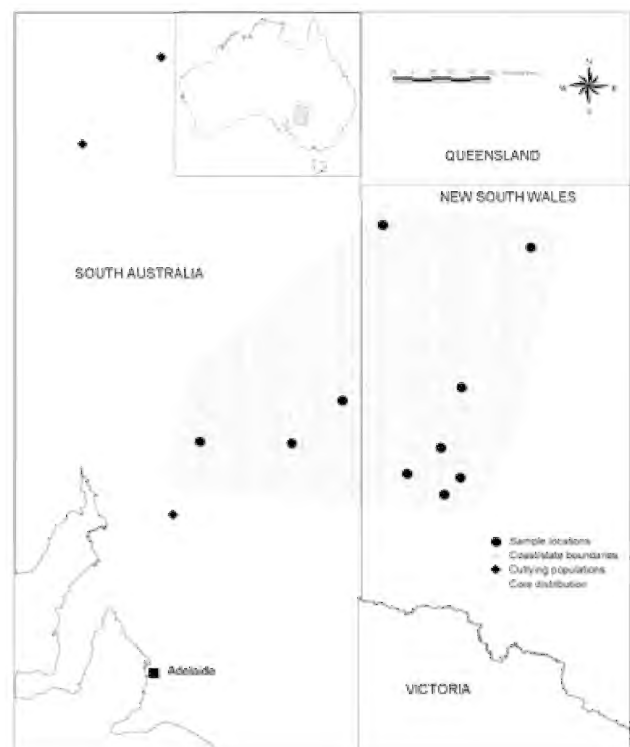
Purple-wood Wattle (*Acacia carneorum*) is a Nationally Vulnerable species confined to west of the Darling River in NSW and to eastern South Australia. It reproduces readily by suckering, but fruits have rarely been observed.

Our investigation of the ecology of Purple-wood Wattle exemplifies the knowledge required to understand and manage decline. This includes:

- evaluation of population sizes and extents (evidence of decline or restricted distribution)
- assessment of population viability (evidence of decline within populations)
- investigation of recruitment limitations (restricted establishment and survival of recruits may explain the status of populations)
- landscape genetic assessment (is there evidence of genetic bottlenecks, inbreeding depression resulting from fragmentation or founder effects?)
- detailed genetic assessment and pollination (are some genotypes more successful than others?)
- experimental attempts to overcome failure to produce fruit (can we induce seed production through addition of suitable pollen?).

## Threats

Auld (1990, 1993) made the first systematic assessment of the abundance and extent of the species and the viability of populations. He confirmed many herbarium records, but found no apparent local extinctions. Standing size structure of populations was used as a surrogate for population viability, with most populations showing a lack of juvenile plants suggesting long term recruitment failure. Seeds collected from two fruit producing sites were large and had a prominent aril that may promote bird dispersal. Seeds were moderately dormant suggesting that a short-lived soil seed bank may exist at these fertile sites (Auld 1993).



Distribution map of Purple-wood Wattle (*Acacia carneorum*), showing sites sampled for molecular (AFLP) analysis.

At Kinchega National Park, southeast of Broken Hill, Auld (1993) also established grazing exclusion experiments that compared survival of new suckers (which emerge in spring and autumn) exposed to: all herbivores; rabbits only; feral goats and kangaroos (domestic stock are excluded from the national park); or no vertebrate herbivores. These indicated that suckers were much more likely to survive if protected from herbivores, particularly rabbits and goats. This then, was one explanation of the unbalanced size structure of most populations and provided a clear management objective to assist in the conservation of the species – reduce rabbit impacts.

In 1995, the rabbit haemorrhagic disease (RHD or RCD) escaped from Wardang Island off the SA coast and rapidly spread into arid NSW. It was hoped that the subsequent reduction in rabbit populations would greatly reduce impacts from rabbits across all tenures. Many commentators predicted rapid transformation of the landscape due to

increased plant recruitment. We took this opportunity to further assess grazing impacts on plants, including Purple-wood Wattle, by establishing new exclusion plots and a new monitoring program. Unfortunately, even with greatly reduced rabbit populations, effective recruitment of palatable shrubs such as Purple-wood Wattle, continued to be low outside of exclosures (Denham & Auld 2004). Furthermore, the very slow growth of suckers indicated that under the current level of grazing pressure, fencing will be required for several decades before plants are large enough to survive intense grazing, even within reserves. However, the arrival of RCD also coincided with the start of what is now known as the ‘millennium drought’, so we hope that an interaction of favourable climatic conditions and reduced grazing impacts might allow better survival and growth of plants in the future.

### Genetics

In 2008, we made a study of population genetics of Purple-wood Wattle using molecular markers (AFLPs). We found very little genetic diversity within stands across the range of the species, which was not surprising given observations of root suckering in many stands. We also found that each stand was quite strongly differentiated, suggesting limited gene flow. Our estimates of clonality ranged from 1-10 clones per stand. Consequently, each stand makes an important contribution to the overall genetic diversity of the species. In addition, we found that the two stands known to regularly produce fruit were among the most genetically diverse. This suggested that limited mate choice may prevent seed production in other stands.

In 2010, with a grant partnered by NSW Office of Environment and Heritage and the University of Wollongong (with support from Catchment Management Authorities) we further extended the genetic studies and initiated investigations of pollination and plant breeding systems in order to explore options for genetic rescue of threatened arid overstorey species. We examined a range of acacias at various levels of threat, including Purple-wood Wattle. Landscape scale genetic analyses confirmed many of our earlier findings. However, the microsatellite data suggested that without exception, each stand is likely to be derived from a single seedling. Furthermore, it appears that a few stands are triploid (with three rather than the usual two copies of chromosomes) and are thus likely to be sterile.

Using seeds from the most fecund stand, we found that two-thirds of all offspring are selfed, suggesting that self-incompatibility and the absence of genetic diversity within stands fails to explain the lack of seed set in most stands. However, it may be that rare genotypes are capable of selfing, and thus produce fruit in the absence of genetic diversity. Nevertheless, the remaining one-third of seeds appears to have been sired by plants from the next nearest stand, some 800 m distant or by plants even more distant (more than 3 km away).

### Pollination

A study examining the floral ontogeny, flower visitor assemblage and pollination of Purple-wood Wattle had some surprising outcomes (Gilpin *et al.* in review). The species was visited by a diverse suite of native insects, including wasps, native bees, flies and butterflies. These native pollinators carried little pollen and were only moderately faithful to Purple-wood Wattle. In contrast, the common and fecund *Acacia ligulata* was almost exclusively visited by the European Honeybee (*Apis mellifera*) which was a highly faithful pollinator.



Butterflies (*Nacaduba biocellata*) on flowers of Purple-wood Wattle (*Acacia carneorum*). Photo Andrew Denham

Floral development (ontogeny) was similar in both *Acacia* species, with little evidence of protogyny (where female phase occurs before male phase in flowers). Since many inflorescences are open simultaneously in both species, many pollen movements are within plants, with outbreeding favoured only through an incompatibility mechanism or selective abortion. We were unable to induce fruit initiation in Purple-wood Wattle through pollination experiments, despite providing pollen from multiple sources. However, pollen tube analysis suggests that we were effective pollinators and that any incompatibility mechanism must be late-acting (sporophytic).

### Conclusions and future directions

The Purple-wood Wattle has survived over 150 years of pastoralism, probably solely due to adult longevity. Grazing continues to be the most pressing threat, and as older stems succumb, regeneration from suckers and seed is crucial. Predictions for climate change in arid NSW suggest modest declines in overall rainfall, with a bias toward summer rather than winter rainfall events. The switch from winter to summer rainfall in the southern part of its range introduces additional drought stress as water availability will be reduced due to increased evaporative loss in summer.

We are yet to determine whether pollination failure is the cause of a lack of fruiting. To further explore this, we plan an experiment using beehives to potentially improve pollination in selected stands to see if this alone will increase fruit production. While germplasm conservation of the species seems prudent, at present only a very small fraction of the genotypic diversity can be captured in this way. Hence, maintaining stands in the wild is essential.

Maintaining a consistent approach to solving problems in the ecology of a threatened plant builds on knowledge that allows informed decisions to be made about recovery or management actions. Publication of research findings is crucial to ensuring that knowledge is not lost.

## References

- Auld, T.D. (1990). Regeneration in populations of the arid zone plants *Acacia carnei* and *A. oswaldii*. *Proceedings of the Ecological Society of Australia* 16: 267-272.
- Auld, T.D. (1993). The impact of grazing on regeneration of the shrub *Acacia carnei* in arid Australia. *Biological Conservation* 65: 165-176.
- Denham, A.J. and Auld, T.D. (2004). Survival and recruitment of seedlings and suckers of trees and shrubs of the Australian arid zone following habitat management and the outbreak of Rabbit Calicivirus Disease (RCD). *Austral Ecology* 29: 585-599.
- Gilpin, A-M., Ayre, D.J. and Denham, A.J. (2012 in review). Can the pollination biology and floral ontogeny of the threatened *Acacia carneorum* explain its lack of reproductive success? *International Journal of Plant Sciences*.

# A phylogenetic and morphological approach in a key Australian plant genus, *Brachyscome*

Megan J Hirst

University of Melbourne, Victoria. Email: mhirst@student.unimelb.edu.au

## Introduction

Understanding the evolutionary radiations of plant species into various habitats is a valuable contribution that can help to predict the adaptive potential of Australian plants. This is especially relevant within the context of climate change as recent climate trends have already had significant impacts on species and ecosystems (Parmesan 2006).

*Brachyscome* is an Australasian genus in the Asteraceae family, having undergone adaptive radiation in Australia. Currently circumscribed *Brachyscome* are predominantly endemic to Australia, with the exception of two Papua New Guinea and four New Zealand species. With more than eighty species in Australia, *Brachyscome* can be found across the continent growing in a vast array of habitats, from high rainfall zones of coastal and alpine areas to the arid regions of Central Australia. *Brachyscome* species have a significant presence in our native flora, excluding the tropics, with relatively common, widespread species growing across a myriad of Australian conditions. Conversely there are species confined to small pockets of habitat. Some species are geographically isolated, such as *Brachyscome segmentosa* which is endemic to exposed rocky ledges on Lord Howe Island. Many are restricted species, such as *Brachyscome muelleri*, and several are considered rare or threatened. Given the variability (i.e. habitat preference and distribution) within the genus, these native daisies provide an opportunity to investigate the relative susceptibility and adaptability of plant species to a changing climate, from an Australian perspective.

“Predicting what will happen to a species distribution in the future must rely heavily on understanding the factors by which they are currently limited.” Lesley Hughes, *Austral Ecology*, 2003.

The distribution of many terrestrial organisms is shifting in response to climate change (Chen et al. 2011). However key traits dictating responses are not well understood. Will widespread species track climatic shifts and therefore adapt to changing conditions? How will restricted species respond? Hughes (2003) argues that one of the most fundamental questions in ecology relates to finding answers to questions such as those posed above, but little is known regarding how Australian taxa will respond under climate change.

“By considering evolution the likelihood that a key plant and animal species will persist within landscapes under climate change can be increased.” Hoffmann and Sgro, *Nature*, 2011.

The future direction as discussed by Hoffmann and Sgro (2011) regarding climate change and evolutionary adaption highlight the critical need to test evolutionary potential across a broad range of species groups, especially groups which can encompass the polarising extremes of environmental conditions. *Brachyscome* is one such group. It is an ecologically diverse genus of flowering plants found throughout temperate Australia. This study proposes *Brachyscome* as a model genus to examine growth and reproductive differences at the species level, within

complexes (i.e. the alpine group) and at different critical life stages. It will involve the acquisition of empirical data and explore evolutionary mapping to gain a greater understanding of the potential for adaptation. This will highlight species considered 'at risk' under a changing Australian landscape, such as those living close to their environmental limits.

### The phylogeny: linking molecules with morphology

Detailed molecular work will investigate the differences between *Brachyscome* species and provide a robust framework to examine their evolutionary relationships. By exploring evolutionary pathways suggested by phylogenetic analysis, a greater understanding of species adaptation and hence their realised and potential distribution may be gained. This study will show which species are most closely related by sequencing *Brachyscome* DNA using coding and spacer regions of a number of chloroplast and nuclear genes. Different plant traits such as leaf area, mature plant height and seed mass along with character states such as an annual or perennial life cycle are then mapped onto the molecular phylogeny. The end result is a *Brachyscome* tree laden with molecular (DNA), morphological (characters) and physiological (traits) data to assist with our understanding and interpretation of species and their current and potential distribution.

### Physiology

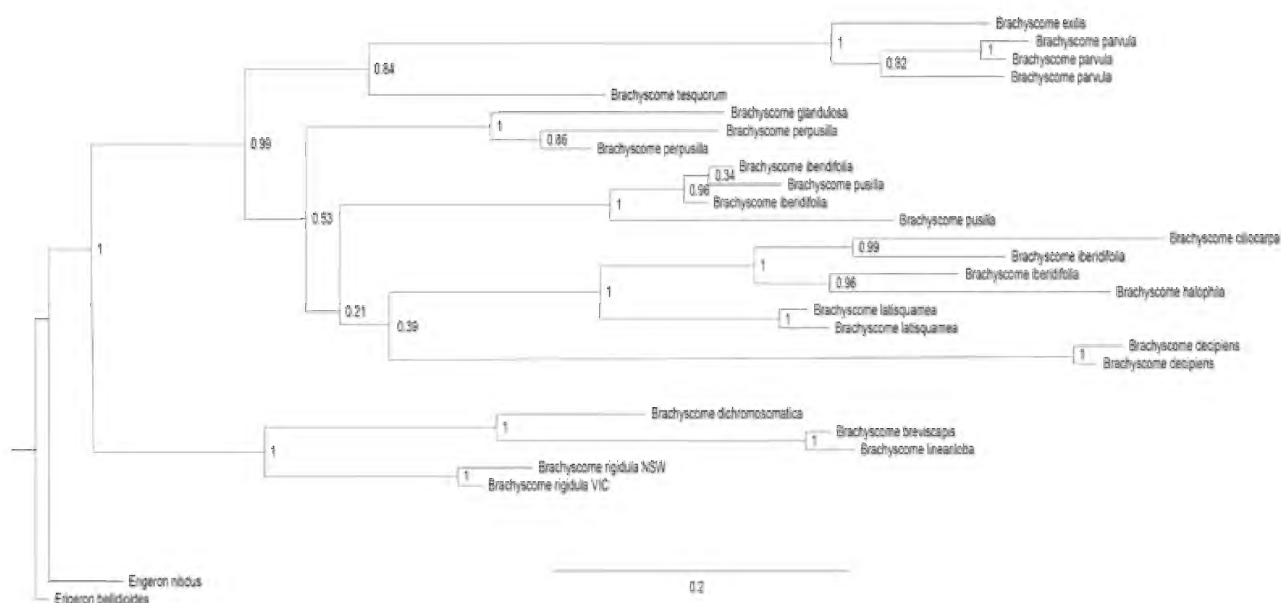
It can be difficult to predict how geographically isolated species respond to critical abiotic stress. Topography, temperature and rainfall can vary considerably from broader regional forecasts. Testing different species from within the same genus (identifying relatedness) under a

range of stressful conditions (depicting climatic scenarios) and comparing how they perform (reproductive fitness) can provide the empirical evidence necessary to project how different members (widespread versus narrow distributions) within *Brachyscome* respond. This approach may highlight potentially vulnerable species due to their current growing conditions and their environmental limits.



The Snow Daisy, *Brachyscome nivalis*, in flower on Basalt Hill, Bogong High Plains, Victoria. Photo Megan Hirst

Alpine *Brachyscome* species are an intriguing group within the wider Australian genus. Of the twelve or so perennial alpine and subalpine species, wide variation can be observed in habitat preference and distribution, endemism, growth habit, and overall morphology. This group provides the unique opportunity to examine key plant traits against a backdrop of varying alpine habitats, such as rocky outcrops, alpine wetlands and plains. Are



A basic phylogeny of selected *Brachyscome* with two nuclear DNA sequences showing relatedness of different species groups. The numbering on the branches indicates the level of support; 1 is the strongest level of support. This phylogeny is a work in progress, and requires more molecular markers to gain stronger support to better interpret the relationships between species.

widespread species, the distribution of which extends into an alpine environment, less likely to show a change in their growth and reproduction compared to species which only occur in an alpine environment when tested in a reciprocal transplant experiment? If widespread species grow over a larger area and perhaps a greater range of climatic conditions, can we assume they will have a greater tolerance to change than species which do not experience such broad conditions?

The topography varies considerably over the Bogong High Plains (as in the Australian Alps generally), with steep slopes, and broad flat valleys incurring profound differences on weather conditions at the local scale (McDougall & Walsh 2007). Three vegetation communities (*Poa costiniana* tussock grassland, Rocky grassland, and Open Heathland) have been selected for their presence of *Brachyscome* species, differences in topography, soil moisture and community assemblage. Each community type has three replicates within the broader Bogong High Plains area. At present approximately 3780 randomised seedlings of seven *Brachyscome* species; *B. decipiens*, *B. rigidula*, *B. scapigera*, *B. tadgellii*, *B. sp. 3 sens. Fl.* Victoria 4:858, *B. spathulata* and *B. nivalis* are in a reciprocal transplant experiment in the Bogong High Plains. Baseline measurements of height/width were recorded at the beginning of the experiment in April 2012, with the second monitoring and measurements due in November 2012. This second census will record the level of species survivorship over the winter period, and whether frost heave or herbivores have had a negative effect on establishment. It will be interesting to see if any patterns emerge between species at this early recording.



The Bogong High Plains with Mt Jim in the background, and moist depressions in the fore. *Brachyscome tadgellii* and *B. decipiens* both occur at this locality; however *B. tadgellii* is only found in this habitat type whereas *B. decipiens* can be found across a broader range. Photo: Megan Hirst

### Engaging the community

Current experimental work is underway in the Australian Garden located within the Royal Botanic Gardens Cranbourne. Nine raised outdoor plots have been set up for testing plant responses to changes in soil moisture and temperature. Twenty four species of *Brachyscome* (from thirty three accessions) are included in the study, representing species found in a wide range of conditions; e.g. coastal, arid, alpine, floodplains, woodland, granite outcrops. There are annuals and perennials; species with a wide geographic distribution and species with very limited population size. This project will provide the opportunity for the general public, whilst visiting the Australian Garden, to view the experimental plots in progress and gain a greater insight into Australian plant conservation, a changing climate and plant science research. Interpretative signage and labelling of treatments will be the major platform to present research questions and ideas, with onsite workshops and education groups encouraged.

### Concluding remarks

This study will examine genetic difference in DNA sequences, morphological characters and states and physiological differences in the Australasian genus *Brachyscome*. Comparison of lineages under varying environmental conditions and levels of abiotic stress will gain a greater understanding in mechanisms of evolutionary adaptation from an Australian perspective. This project brings science into a public setting, demonstrating methods of experimental work with the aim to encourage future students into science, preferably plant science!

### Acknowledgments

I would like to thank my PhD supervisors Prof. Ary Hoffmann, Neville Walsh and Dr. Adam Miller, the ANZ Trustees Foundation Holsworth Wildlife Research Endowment, The University of Melbourne 2012 MacBain Research Scholarship in Biology, the Australian Seed bank Partnership for donating seed samples of *Brachyscome* and *Allittia* species, and The Royal Botanic Gardens for their ongoing support especially evident in the Australian Garden research plots located within the Cranbourne Botanic Gardens with special mention to RBGC nursery staff members Bronwyn Swartz and Cali Calzmann.

### References

- Chen D. I. C., Hill, J. K., Ohlemuller, R., Roy, D. B., and Thomas, C. (2011). Rapid range shifts of species associated with high levels of climate warming. *Science*. 333, 1024 – 1026.
- Hoffmann, A. A., and Sgro, C. M. (2011). Climate change and evolutionary adaptation. *Nature*, 470, 479 – 485.
- Hughes, L. (2003). Climate change and Australia: Trends, projections and impacts. *Austral Ecology*, 28, 423 – 443.
- McDougall, K. L and Walsh, N. G. (2007). Treeless vegetation of the Australian Alps. *Cunninghamia*. 10, (1). 1 -57.
- Parmesan, C. (2006). Ecological and evolutionary responses to recent climate changes. "Annual Review of Ecology, Evolution and Systematics". 37, 637 – 669.

# Saving private rhizomes: private land initiatives which encourage and support in-situ plant conservation

Jeff Kelleway<sup>1</sup> and Lynn Webber<sup>2</sup>

<sup>1</sup> Molino Stewart Pty Ltd, Parramatta, NSW. Email: jkelleway@molinostewart.com.au;

<sup>2</sup> NSW Office of Environment and Heritage, Sydney, NSW. Email: Lynn.Webber@environment.nsw.gov.au

Private lands cover all facets of the Australian landscape and contain many of our unique threatened plants, populations and ecological communities. With approximately 70% of Australia's land area privately owned or managed (freehold, leasehold or Indigenous-owned) (Figgis et al. 2005), there is growing recognition of the role initiatives on private lands can play in conserving biodiversity values.

The National Reserve System (NRS) is Australia's network of public (and some privately managed) protected areas. It currently represents approximately 13% of the country's land area (Australian Government, 2010). Whilst public protected area systems aim to provide comprehensive, adequate and representative protection for Australia's biodiversity assets, historical and contemporary patterns of land-use have resulted in many biodiversity assets being under-represented in public reserves. This is of particular concern for plant species, populations and ecological communities, which are essentially immobile and require targeted in-situ conservation.

A review was undertaken of private land conservation mechanisms operating internationally (North America, United Kingdom, New Zealand and southern and

eastern Africa) and within Australia. A diverse range of mechanisms were identified, the vast majority of which are voluntary for the landholder. These have been grouped into six major categories, although it should be noted that in many cases private land conservation models incorporated mechanisms from more than one category. Many examples also involved partnerships between landholders, government agencies and/or non-government organisations (NGOs).

## Cost-share agreements

Cost-share agreements or direct funding arrangements provide financial incentives to landholders to undertake conservation management on their land. Such incentives may be one-off (and linked to a longer-term contract) or provided over longer durations. A variety of competitive and non-competitive grants and government funds may be offered, usually in relation to a covenant or other agreement.

### Case study: US wetland reserve program

The US Wetland Reserve Program provides an example of combining conservation covenants and long term management agreements. The program provides increasing incentive with higher levels of landholder commitment. For example, the landholder:

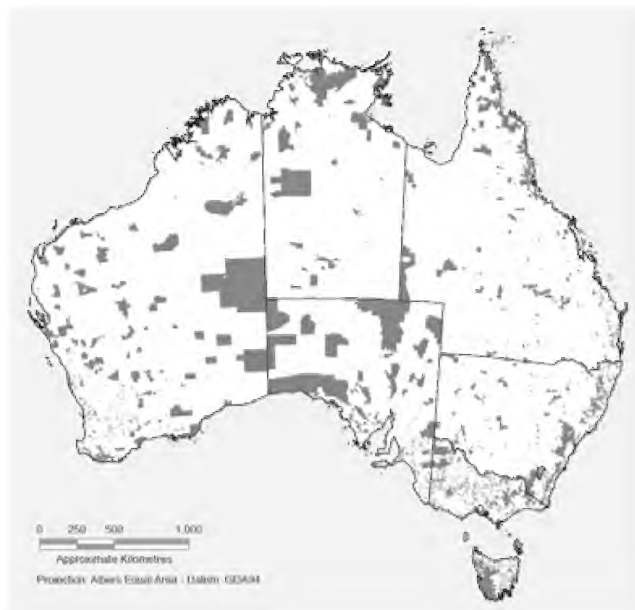
- receives 100% of the easement value and up to 100% of restoration costs for placing a covenant in perpetuity
- receives up to 75% easement value and restoration costs for a 30 year agreement
- may receive up to 75% restoration costs for a non-termed agreement.

## Taxation incentives

Tax incentives in the form of deductions and/or exemptions can be provided to landholders or NGOs which donate land or money for conservation purposes (including covenants). This is a major part of the private land conservation framework in Canada.

### Case study: the Canadian experience

Under the Ecogifts program, donors of land or a partial interest in land (e.g. conservation covenant) may be able to receive income tax benefits. Donations must be in-



Map of the National Reserve System. Source: Department of Sustainability, Environment, Water, Communities and Population.

perpetuity and can be made to certain eligible NGOs and government agencies.

In the province of Nova Scotia, the split receipting mechanism allows a willing landholder to sell their land to a private conservation organisation or a government for less than the market value, and claim the rest of the land value as a tax deductible gift. For example, a landholder may sell their land valued at \$50 000 for \$30 000 and claim the remaining \$20 000 as a tax deductible gift.

### **Market-based mechanisms**

Market-based stewardship incentives (e.g. Conservation Banking in the United States; BioBanking in NSW; BushTender in Victoria) provide a tool through which private landholders may derive financial benefit from the protection or restoration of biodiversity values on their land. Such mechanisms may also allow for the offsetting of environmental impacts (e.g. to endangered species habitat) associated with a development or impact either within the same landholding or similar environments.

Carbon-trading schemes such as Australia's Carbon Farming Initiative and other international schemes may represent a significant and growing market-based mechanism for private land conservation in the years to come.

### **Private reserves**

A number of private and community-based private reservation types exist throughout southern and eastern Africa, where non-consumptive (e.g. wildlife tourism) and consumptive (e.g. hunting) wildlife based land uses apply.

### **Designated (non-voluntary) conservation on private land**

Existing or new legislation is used to designate conservation features and land-use and management requirements within these areas are regulated. This mechanism is used mostly in the United Kingdom where a large proportion of the conservation estate is on private land and may be designated as a Site of Special Scientific Interest.

### **Covenants**

Conservation covenants or 'conservation easements' involve a landholder (individuals, land trusts or NGOs) legally designating a portion of land for conservation purposes. Most jurisdictions have one or more covenanting mechanisms in place, with protection in perpetuity afforded by the registering of the covenant on the land title. This binds all future owners to the land-use and management conditions entered into under the covenant. Many covenant initiatives involve support in terms of services and/or finance to maintain covenanted areas.

### **Case study: conservation covenants in Australia**

There are broad similarities in the private land conservation models used across Australia. All States have a covenanting

scheme; however, governance, funding arrangements, landholder incentives and covenant flexibility vary between jurisdictions.

The Commonwealth government has the legislative capacity to enter into a conservation covenant directly with landholders, however, in almost all cases it partners with or provides funds for State and Territory Governments (or NGOs) in a strategic approach. A key feature of the Commonwealth's approach is that covenants are to be consistent with IUCN Protected Areas Categories System and included in the National Reserve System.

Indigenous Protected Areas (IPAs) are also managed within the National Reserve System. They are areas of Indigenous-owned land and/or sea where traditional owners have entered into an agreement (not necessarily perpetual) with the Australian Government to promote biodiversity and cultural resource conservation.

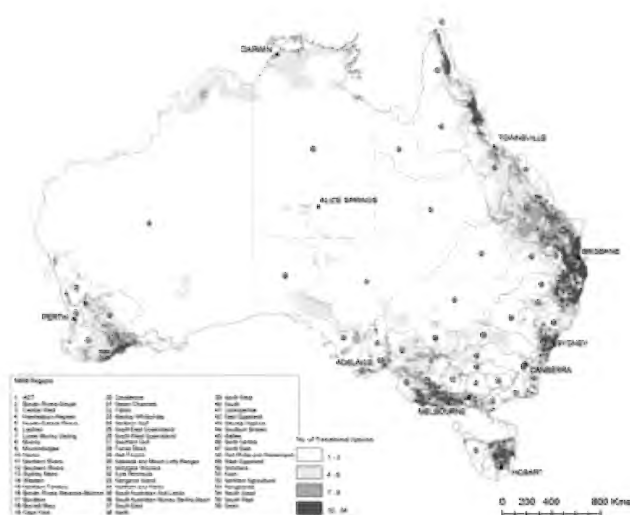
South Australian Heritage Agreements have been established to protect and conserve native vegetation. A review of options has recently been undertaken with a view to align private land conservation activities with the National Reserve System.

In Tasmania, covenants are administered under the 'Protected Areas on Private Lands' partnership between the Tasmanian Government, Tasmanian Land Conservancy (an NGO) and the Commonwealth Government.

In both Victoria and Western Australia conservation covenants can be made between landholders and the state based land trusts – Trust for Nature (Victoria) and National Trust of Australia (WA) respectively. Both of these organisations operate 'revolving funds', whereby properties are purchased, a covenant is placed on them, they are sold to a willing buyer and the sale funds are used to purchase further properties.

The New South Wales Office of Environment and Heritage (OEH) administers the Conservation Partners Program. Like many of the initiatives seen overseas and within Australia, the Conservation Partners Program offers an increasing level of landholder support with increasing landholder commitment. The highest level of commitment from a landholder is the signing of a Voluntary Conservation Agreement. This is a legally binding, in-perpetuity covenant registered on the land title. OEH inspects the property, develops a legal agreement with detailed management strategies, provides advice and funds for on-ground works and property signage. Financial incentives to landholders may include Local Government Rate exemption, State Land Tax exemption, income tax deduction and concessional capital gains tax treatment.

Landholders in NSW can also enter into an agreement with a statutory NGO – the Nature Conservation Trust of NSW. Benefits to landholders include State Land Tax concession and in some specific cases there may be provision of funding for management works. An attraction of this mechanism for some landholders is that it the



Density and distribution of threatened species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Source: Department of Sustainability, Environment, Water, Communities and Population.

agreement is made directly with the Trust, rather than a government agency.

In Queensland, Nature Refuges are established under the *Nature Conservation Act 1992*. The program includes a flexible covenant scheme made on a case-by-case basis. This may include the ability for the landholder to undertake low-impact production within the Nature Reserve.

In some jurisdictions, local government may also enter into conservation covenants with willing landholders. In NSW, councils have the opportunity for covenanting under Section 88e of the *Conveyancing Act 1919*. In Queensland,

local government may enter a covenant under the *Land Title Act 1994* (for freehold land) and *Land Act 1994* (for non-freehold land). To date local government conservation covenants have been relatively rare.

Throughout Australia there are also a number of NGOs which undertake private land conservation through the purchase (often including placement of a conservation covenant) and/or management of private lands for conservation. Active NGOs in this area include the Australian Wildlife Conservancy, Bush Heritage, Birdlife Australia and the Nature Conservancy.

### Conclusion

There is growing recognition of the role private land conservation can play in complementing public protected area systems. This is particularly important for threatened communities, populations and species which are poorly represented in the public reserve system and will benefit most from in-situ conservation efforts. There are a broad range of mechanisms used within Australia and in similar jurisdictions which provide support and financial incentives for landholders to conserve biodiversity values on their land. An understanding of the diversity of mechanisms available and their governance across jurisdictions will provide inspiration for the review and improvement of biodiversity conservation policy and programs.

### References

- Figgis, P., D. Humann and M. Looker. 2005. Conservation on private land in Australia. *Parks* 15:19–29
- Australian Government (2010). *CAPAD 2010 – Protected Area Data* [online] <http://www.environment.gov.au/parks/nrs/science/capad/2010/index.html>. Last Updated 12/09/2012. Accessed 21/09/2012.

## Non Government Organisations – research and botanic gardens

David Coutts

President, Friends of the Australian National Botanic Gardens

### Introduction

The ANPC conference theme of Plant Conservation in Australia – Achievements and future directions focuses on important issues that are not always fully appreciated by Governments or the wider community.

I come to this topic as President of the Friends of the Australian National Botanic Gardens (ANBG) and with a long standing personal interest in native plants. The Friends is a significant group with about 1800 members.

We operate totally on a voluntary basis, which is quite a challenge at times. Our role is to support the ANBG and I want to address the subject from that perspective.

Our aims, as set out in our Constitution, include:

- Supporting the Gardens
  - in the protection and enhancement of the natural environment through the conservation of a significant collection of the Australian native flora

- in research into and display of the diversity of plant life, its ecological and geographic distribution and its horticultural values
- in providing information and education to the community about growing, studying and promoting Australian plants through lectures, workshops and guided tours
- Raising money for the Gardens.

Drawing on our experience over a number of years as an NGO, we can:

- Help identify the priorities for native plant research and how ANBG can contribute to that
- Provide in kind input to agreed research projects
- Provide funding to agreed research projects
- Help educate the community on the importance of native plants and why it is vital for them to be studied
- Science is not always adequately appreciated in the wider community
- Help bring together the researchers and the community to support key projects and disseminate the results.

### Supporting research

At ANBG the Friends have been moving to increase our support for research in a number of ways:

#### Providing volunteers

- In recent times this includes support in the seedbank, an Australian Research Council (ARC) project on alpine seeds, collection of seeds in the ACT region and collection of data for project investigating *Acacia* pollination.
- To be effective the volunteers must be properly trained in what is needed. If not then the work they do and the data they collect may be of limited use
- We have started to gain some expertise in this area and this has coalesced into an ongoing group of 'seedy volunteers'
- The key component of this in kind support is commitment by the researchers to use the volunteers effectively and have the time and patience to quality control the activities.

#### Providing funding for research projects

- Fund raising is a key component of what the Friends of ANBG do.
- The new Management Plan for the gardens sets out many excellent and important priorities and actions but the necessary resources to deliver those priorities are going to be very hard to find. NGOs such as the Friends of ANBG can play a key part in harnessing such resources and fine tuning the priorities.
- Involvement of NGOs can be used to leverage funding from other sources in joint funded projects. That



*Seed hunters on the Main Range Track, Snowy Mountains. An ARC project jointly funded by the Friends.  
Photo: Bindy Vanzella*

includes Government, research funding bodies such as ARC and the private sector.

- The alpine seed project at ANBG is a good example of what can be achieved. This was awarded a grant from the ARC and involves ANBG, ANU, the University of Queensland and the Friends of ANBG. The Friends have contributed \$66 000 to this project over 3 years plus significant in kind support. The involvement of the Friends as a community group was vital in achieving the funding for this project.
- Funding from the Dahl Trust for a new Eucalypt walk was provided through the Friends and additional funding by the Friends is also being made available.

#### Replacement of resources

- There is a fine line between what NGOs should do and what should be done by Government funded resources.
- This is true at ANBG, where the Friends and Management have agreed the relative roles in a Memorandum of Understanding (MOU), with the functions associated with actual management of the Gardens being outside the Friends direct responsibility. This MOU is reviewed regularly.

#### Advocacy

- An NGO group like the Friends of ANBG has a really important role as an advocate for the institution.

#### Establishing a Plant Research Group

- Growing out of our ad hoc involvement in projects in recent years, including support of the Botanical Resource Centre we are moving to establish a Plant Research Group.
- At the moment the idea is that this would be a group of Friends wishing to enhance their knowledge of Australian plants and improve their skills in plant identification and provide a forum for a discussion of wider aspects related to native plants and research.

There is also what I call citizen science projects, where the public and/or volunteers might collect data with fairly light, if any, direct supervision. One example is the Climate Watch Trail, a project of Earthwatch, which the Friends have supported at ANBG. This encourages visitors to record data for certain plants and lodge that data. It seems to me that where this could be really useful is long time series data, which is going to be most important in relation to climate change but it will need some commitment to ongoing supervision.

### Conclusion

Research on native flora is absolutely vital and probably always will be under pressure for adequate resources. A range of issues make this research ever more important, including climate change, environmental degradation in Australia and potential uses of native plants for food, medicines, energy. Much of the necessary research is long term, especially in relation to climate change.

NGOs can provide significant help to scientists in relation to this research through:

- Provision of funding, both directly and through leveraging wider funds in jointly funded projects.
- Support of research projects through in kind support; this can be the time and skill of volunteers and the provision of equipment and other facilities.

NGOs can be a mechanism for bringing a range of views and expertise to the setting of priorities for research. They can also play a really important part in raising awareness in the community of the importance of native flora and research through support of various tools and materials to inform the community, such as websites, printed

material and events as well as acting a public advocate for the institution. There is support for establishment of an Advisory Council for the Gardens to bring a wider range of expertise to bear on key management decisions.

Scientists also need to see the value of NGOs and their volunteers. Researchers need to structure the project to effectively use volunteer resources and allow for necessary training and supervision.

I look forward to a very productive future relationship between research on native plants and the Friends of ANBG. The Friends are dedicated to seeing the collection is maintained at a high standard and used in the best possible way to address the challenges facing the Australian environment.



Native orchid display. Supported by the orchid society and the Friends. Photo: Alan Munns

## Horned Pondweed at Sydney Olympic Park

Swapan Paul and Tina Hsu

Sydney Olympic Park Authority. Email: Swapan.Paul@sopa.nsw.gov.au

### Background

Horned Pondweed (*Zannichellia palustris*) is a submerged, weakly rhizomatous aquatic annual or perennial plant. NSW populations behave as annuals, dying back completely every summer (OEH, 2011). It occurs in fresh to brackish, still-to-slowly moving waters. In Australia, *Z. palustris* was only known from the Murray River estuary in South Australia and the Lower Hunter region in NSW until a small population was identified at Sydney Olympic Park NSW, in December 2010. *Z. palustris* can be recognised by long, narrow, thread-like leaves. Its roots are tendril-like, and its seeds bear a distinctive horned shape, hence

the common name, Horned Pondweed (DNR, 2010). It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, and is listed as a rare species under Schedule 9 of South Australia's *National Parks and Wildlife Act 1972*.

### Habitat description

Identification of *Z. palustris* collected within Sydney Olympic Park was confirmed in 2010 by the Royal Botanic Gardens Sydney. The species was found within Bennelong Pond, in an (estuarine) mangrove system which ultimately opens out to Homebush Bay and Parramatta River.

The Pond receives stormwater runoff via two major inlets from adjacent but separate sub-catchments of approximately 35 ha and 70 ha, resulting in lower water salinity than estuarine water. Freshwater inflow is generally gentle with very high fluxes after heavy rain; water depth is generally around 150-200 mm, reaching 700 mm in pockets at times of heavy flow. The pond does not dry up completely except during prolonged droughts, as occurred in 2003-04. Surveys of other wetlands within the Park with similar habitat to Bennelong Pond did not identify the presence of *Z. palustris*.



Indicative extent and density of *Z. palustris* in Bennelong Pond, Sydney Olympic Park

### Monitoring program

A survey followed by a monitoring program commenced in 2011 to investigate the species' ecology and status, so as to contribute to the development of a conservation and management plan, and to allow informed decisions to be made on operational activities and/or development proposals that may affect this endangered species.

After the initial surveys, fortnightly monitoring was conducted at Bennelong Pond from mid-April 2011 to early-February 2012, then reduced to a monthly interval until the end of April 2012. The Pond was divided into three areas, based on past observations of *Z. palustris* coverage. Three replicate quadrats were placed randomly in each area.

Data was gathered on *Z. palustris* coverage, conductivity of sediment, and various water quality parameters including, depth, dissolved oxygen, temperature, conductivity, pH and turbidity. Notes were taken on general conditions of *Z. palustris* such as stage of growth, overall health and vigour, grazing by waterbirds and algal coverage. Weather data was obtained from the Bureau of Meteorology.

Data was analysed with two factor ANOVA (area x monitoring date) to investigate temporal and spatial changes to the species and its environment. Subsequently, a one factor ANOVA was used to analyse data from Area 1 as significant differences were found in parameters measured among the monitoring areas.

### Results and discussion

*Z. palustris* coverage was significantly higher in Area 1 compared to Areas 2 and 3; coverage in Area 2 was also significantly higher than in Area 3. The only parameters that exhibited the same pattern were water depth and water conductivity, while other parameters exhibited an inverse pattern. This suggests Area 1 was characterised by significantly greater water depth and water conductivity, and markedly lower temperature, dissolved oxygen, turbidity, and sediment conductivity compared to Areas 2 and 3.

Mean readings and standard error (s.e.) of water quality parameters and coverage for each monitoring area

|                            | Area 1<br>mean | ±s.e. | Area 2<br>mean | ±s.e. | Area 3<br>mean | ±s.e. |
|----------------------------|----------------|-------|----------------|-------|----------------|-------|
| Temperature (°C)           | 16.55          | 0.42  | 16.90          | 0.41  | 17.65          | 0.41  |
| Dissolved Oxygen (ppm)     | 6.41           | 0.25  | 6.73           | 0.28  | 7.60           | 0.25  |
| Water Conductivity (µs)    | 890.08         | 61.75 | 770.77         | 45.42 | 677.68         | 16.12 |
| Sediment Conductivity (mS) | 6.57           | 0.13  | 7.22           | 0.19  | 7.89           | 0.15  |
| Turbidity (NTU)            | 4.82           | 0.23  | 6.44           | 0.36  | 9.43           | 0.34  |
| pH                         | 7.84           | 0.09  | 7.85           | 0.06  | 8.00           | 0.06  |
| Depth (cm)                 | 33.18          | 0.37  | 27.03          | 0.35  | 23.96          | 0.23  |
| Cover (%)                  | 48.21          | 3.40  | 31.54          | 4.77  | 16.33          | 5.66  |

Note: s.e. = standard error

Two factor ANOVA comparisons of water quality parameters and coverage among the three monitoring areas

| Parameters            | Significant differences among areas ( $P < 0.05^*$ or $P < 0.01^{**}$ ) |
|-----------------------|---|
| Temperature           | 1 $^{**}$ 2 $^{**}$ 3   |
| Dissolved Oxygen      | 1 $^{**}$ 2 $^{**}$ 3   |
| Water Conductivity    | 3 $^{**}$ 2 $^{**}$ 1   |
| Sediment Conductivity | 1 $^{**}$ 2 $^{**}$ 3   |
| Turbidity             | 1 $^{**}$ 2 $^{**}$ 3   |
| pH                    | 1=2 $^{*}$ 3  |
| Depth                 | 3 $^{**}$ 2 $^{**}$ 1   |
| Coverage              | 3 $^{**}$ 2 $^{**}$ 1   |

Small numbers of *Z. palustris* individuals (and some uprooted plants) were detected in Areas 1 and 2 during preliminary surveys in early February 2011. By April, young *Z. palustris* were seen in all three monitoring areas, some growing from runners and others probably from seed. As the plants matured throughout May, signs of grazing and uprooting by waterfowl became evident, and feeding on water plants was observed on occasions.

Despite some grazing, *Z. palustris* continued to mature and expand. Some dieback occurred in June, following a rain event and a dense bloom of filamentous algae. As the new crop showed signs of maturation once again throughout June and July, signs of damage and reduction in coverage through foraging by waterfowl became evident. By the end of July, *Z. palustris* of different cohorts was present in all areas, with most areas showing signs of disturbance and damage (uprooted, grazed or broken plants). Grazing appeared to be the primary reason for the cyclic pattern of damage-recovery for the species, at least between May and July. Presence and coverage of floating vegetation such as *Azolla* was variable and did not have an appreciable influence on *Z. palustris* coverage.

Dieback of *Z. palustris* was noted during monitoring in mid-August, affecting Areas 2 and 3 in particular. An increase in average water depth coinciding with a spike in turbidity, water conductivity and sediment conductivity, and a decrease in dissolved oxygen also occurred. The

triggers for this dieback was most likely related to an increased inflow of rainfall (132.1 mm) and episodes of very high turbidity throughout July.

Regrowth of surviving young *Z. palustris* and recovery of maturing plants after this dieback was accompanied by signs of grazing in all areas. By November the plants have substantially recovered but the recovering plants were covered by silt and dead filamentous algae, which may have lessened its appeal as a food source for waterfowl for some time. Despite grazing and some dieback, flowering was observed in all Areas throughout October and November. Seed-heads were seen in December, however, the plants were again smothered by dense and dying filamentous algae, and most of the plants were dead within 2 weeks. Complete dieback of *Z. palustris* was observed during the summer months of January and February.

## Conclusions

The overall changes in coverage were most probably seasonal, hence temperature dependent. While *Z. palustris* demonstrated seasonal pattern of growth and dieback in the study area, coverage, health and resilience of *Z. palustris* differed among the three monitoring areas. Most water quality parameters monitored, other than turbidity, did not have any notable effect on the survival or coverage of *Z. palustris*. Further investigation is required to elucidate the relationship and determine optimum ranges in relation to *Z. palustris* health and coverage.

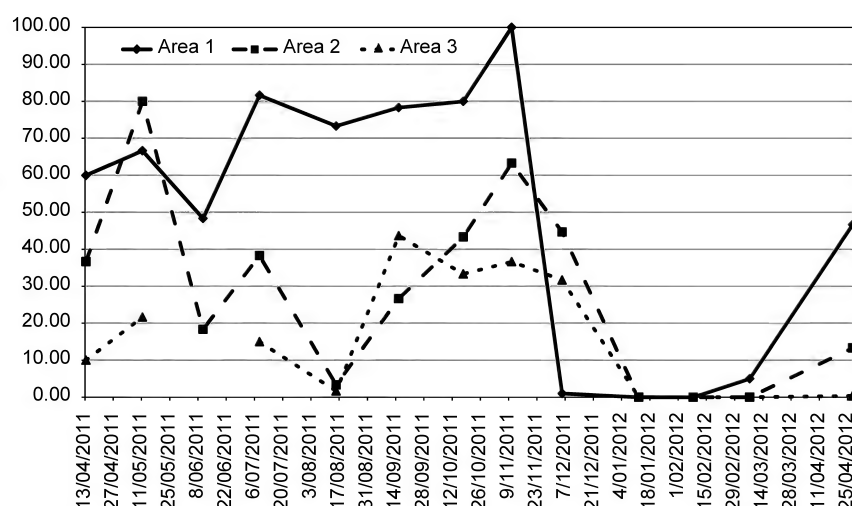
## Acknowledgements

Our thanks to the Sydney Royal Botanic Gardens for their assistance in identifying the plant, and to Sydney Olympic Park Authority staff who provided comments on this paper.

## References

- DNR (Department of Natural Resources, Maryland) (2010). *Horned Pondweed Zannichellia palustris*. [http://www.dnr.state.md.us/bay/sav/key/horned\\_pondweed.asp](http://www.dnr.state.md.us/bay/sav/key/horned_pondweed.asp)
- OEH (Office of Environment and Heritage NSW) (2011). *Zannichellia palustris – profile*. <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10847>
- OEH (Office of Environment and Heritage NSW) (2012). *Zannichellia palustris (a submerged aquatic plant) – endangered species listing*. <http://www.environment.nsw.gov.au/determinations/ZannichelliaPalustrisEndSpListing.htm>
- USDA (United States Department of Agriculture) (2012). *PLANTS Profile. Zannichellia palustris L. horned pondweed*. <http://plants.usda.gov/java/profile?symbol=ZAPA>

Average *Z. palustris* coverage in Area 1, 2 and 3 in Bennelong Pond, Sydney Olympic Park. (Values are averages of three replicates).



# Report from New Zealand Plant Conservation Network

*Kerry Gillbanks*

*Auckland Council, NZ. Email: [kerry.gillbanks@aucklandcouncil.govt.nz](mailto:kerry.gillbanks@aucklandcouncil.govt.nz)*

## Interactive plant keys

Landcare Research has developed several useful interactive plant keys that provide accurate identification of plants found growing in New Zealand. These online keys were funded by the Terrestrial and Freshwater Biodiversity Information Programme (TFBIS) Programme, a fund administered by the Department of Conservation. Keys are available on the following plants - Coprosma species, grasses, native orchids, weed species, flowering plants that are wild and casual, native plants of schools and marae in New Zealand and weedy daisies of the South Pacific. The Lucid key interface is divided into four panes – the left hand panes are the features and the right hand panes are the entities. As you start selecting the features for identifying your specimen, these appear in the bottom left hand pane and the entities are eliminated from the bottom right pane. Pictures and webpage information is available with the chosen plant names.

Visit <http://www.landcareresearch.co.nz/resources/identification/plants> to use the keys.

## Annual Plant Conservation Network awards

The Network's AGM was held on Thursday 29 November where the Annual Plant Conservation Network Awards were announced. The awards are to acknowledge outstanding contributions to native plant conservation. The individual award went to Alice Shanks, a long time plant conservation advocate in her local Canterbury community. Plant nursery went to Pukerau Nursery, run by Arne and Jenny Cleland in the lower South Island. They have a great ability to communicate with landowners encouraging them to plant natives and have grown plants for the Department of Conservation, local landcare groups and Forest and

Bird. The School award went to Raumati South School on the Kapiti Coast. They have created a bushwalk on their school grounds and their main goal for it - not being able to see the school buildings. They have planted over 4000 native plants in the grounds. The Community award went to the Nelson Branch of Forest and Bird for their efforts in restoring an estuarine ecosystem at Paremata Flat, just north of Nelson. The Local Authority awards goes to Hutt City Council for purchasing land - Baring Head on the Wellington South Coast, identified as having a high conservation value. The Council supports the Friends of Baring Head that works to enhance and promote the area.

The Life Time Achievement Award went to John Dawson for his contribution to botany over his lifetime. John is a former associate professor of botany at Victoria University but would be best known for his books, co-authored with Rob Lucas. Their latest book – New Zealand's Native Trees, recently won the NZ Post Book of the Year award and a special award was given to the New Zealand Transport Agency for their commitment to planting roadways in native species. They have carried out a number of major highway projects where native trees have been planted on road completion.

## Network/Website updates

In conjunction with the Auckland Botanical Society, Landcare Research Manaaki Whenua and Massey University the NZPCN Conference will be held in Parnell, Auckland from Thursday 23rd May through to Sunday 26th May. Mark this in your calendars. The conference programme is yet to be finalised but visit our website for the symposia.

Look out for our new look website in the New Year. Visit [www.nzpcn.org.nz](http://www.nzpcn.org.nz) for more information.

---

# ANPC workshop report

*Tricia Hogbin*

*Australian Network for Plant Conservation, [projects@anpc.asn.au](mailto:projects@anpc.asn.au)*

In the last few months of 2012 the ANPC hosted a flurry of workshops across NSW. The four workshops covered a range of topics related to the conservation and management of native vegetation.

One of the main strengths of these workshops was the diversity of presenters and participants involved. For example, 30 different presenters were involved in the delivery of the four workshops.

The workshops received positive feedback and provided invaluable hands-on learning and networking opportunities.

Full workshop reports, including presenter details, images and presentation slides can be found at [anpc.asn.au/courses.html](http://anpc.asn.au/courses.html).

Following is a brief summary of each workshop.

### **Managing significant native vegetation remnants, Scone September 2012**

The fourth workshop in our Jewels in the Landscape series was held in Scone in September. This two day workshop, supported through a grant from the NSW Environmental Trust, delivered theory and practical training in managing significant native vegetation remnants such as travelling stock reserves and roadside remnants.

Day one commenced with presentations on the ecology of grassy woodlands; weed management in grassy woodlands; grazing for biodiversity; grassy woodland restoration; planning a management and restoration project; and pre-survey desk-top research. We finished the day with a field activity on plant identification.

We commenced day two at Wingen Cemetery where participants learnt how to identify the natural values and threats for a site; identify vegetation communities; and practiced a range of vegetation monitoring techniques.

The workshop closed with a range of case study presentations.



*Paul Melehan of Hunter Central Rivers CMA demonstrating the establishment of photo point monitoring sites.  
Photo: Tricia Hogbin*

### **Plant identification for grassy ecosystems (Riverina and South West Slopes), Deniliquin September 2012**

The fifth workshop in our Jewels in the Landscape series was on plant identification for grassy ecosystems. This workshop proved popular with over 50 participants attending the two day workshop in Deniliquin.

Day one started with introductory presentations on the ecology and diversity of grassy ecosystems and introduction to plant identification and available resources. A practical activity on botanical terminology and plant morphology followed. We then focussed on plant identification for some common families including grasses, sedges, rushes, daisies, lilies, and orchids.



*Noushka Reiter of Wimmera Catchment Management Authority providing advice on orchid identification. Photo: Tricia Hogbin*

Day two we covered the use of interactive identification keys and then spent the remainder of the day in the field undertaking practical activities.

### **Seed collection, storage and use for native vegetation restoration, Mt Annan November**

This workshop provided participants with the knowledge needed to effectively collect, store and use seed in native vegetation restoration. The workshop, based on the ANPC's *Plant Germplasm Conservation Guidelines*, was very popular, with interest exceeding capacity.

Given the success of this workshop it will be rolled out across Australia over the next two years (see note below regarding future ANPC workshops).

The first half of the day provided an overview of the theory, including presentations on seed collection; pest and disease management; and seed banking including cleaning, storage, testing and longevity.

A series of case study presentations followed, including presentations on identifying high quality seed sources, germination and storage of threatened orchid species, storage of seed for rainforest species, and the use of seed orchards.

The day closed with a collection of workshop activities that saw participants testing seed viability and learning how to clean seed.



*The seed use for native vegetation restoration workshop included a range of hands-on activities. Photo: Tricia Hogbin*

### **Translocation of Threatened Plants, Mt Annan November**

The Mt Annan Translocation workshop marked the 15th time this successful workshop has been delivered since 2004. Participants enjoyed a range of networking opportunities and left with a sound understanding of the role of translocation in the conservation of threatened plants.

The workshop commenced with theory presentations covering: deciding when to translocate; pre-translocation assessment, planning and preparation; implementation, ongoing management, monitoring and evaluation; and community group involvement.

Five case studies were presented for a range of threatened plants - including the Wollemi Pine. The day closed with a presentation on translocation policy, licensing and approval and a workshop activity where participants were able to test some of their new found knowledge and learn from the experience of other participants.

Day two of the workshop included a tour of the NSW Seed Bank and Cumberland Plain Woodland restoration at The Australian Botanic Garden. We then went on to tour a range of Western Sydney translocation recipient sites.

### **Acknowledgements**

Thirty different presenters and additional helpers assisted in the delivery of these workshops. Their assistance was invaluable and their involvement is greatly appreciated. Being too numerous to mention in this article, all presenters are acknowledged in the full workshop reports which can be found at [anpc.asn.au/courses.html](http://anpc.asn.au/courses.html).

### **Future ANPC workshops and additional information**

Currently scheduled workshops include:

- Plant Identification for Grassy Ecosystems, Canberra ACT 13-14 March
- Seed collection, storage and use for native vegetation restoration, Sunshine Coast Qld 3-4 April 2013
- Translocation of Threatened Plants Sunshine Coast Qld 4-5 April 2013.

Registration to open January 2013. ANPC will also be delivering the Seed and Translocation workshop at further locations across Australia throughout 2013 and 2014.

For more information on past and future ANPC workshops visit [anpc.asn.au/courses.html](http://anpc.asn.au/courses.html).

## **Conferences and Workshops**

### **East Coast Biodiversity Offsetting for Mining, Energy & Infrastructure Development**

*12 - 13 February 2013  
Brisbane, QLD*

East Coast Biodiversity Offsetting will explore policy developments and emerging industry approaches for biodiversity offset delivery in Queensland and New South Wales.

Mining, energy and infrastructure proponents are currently facing large and complex biodiversity offset requirements to successfully achieve project approvals and net positive impact on biodiversity.

For the full speaker line-up and conference agenda visit: <http://biodiversityoffsetdelivery.com/agenda/>

### **Plant identification for grassy ecosystems ANPC workshop**

*13 - 14 March  
Canberra, ACT*

This two day workshop will introduce participants to grassy ecosystems, their diversity and ecology, and provide the skills and information required to positively identify a range of common grassland plants.

Some of the most commonly encountered plant groups, including grasses, eucalypts and daisies, will be used to introduce you to the best identification resources (printed, on-line, and interactive). You will also learn how to access the

experts through the identification services of the major herbaria. Along the way identification 'keys' will be de-mystified, and you'll be introduced to useful field characters to look for.

Learning will be through a combination of theory presentations and field-based activities. This workshop is targeted at the beginner level, but will also provide a good opportunity for those more experienced in plant identification to refresh their skills.

For more information, including a full program, flyer and registration form please visit <http://anpc.asn.au/courses.html>.

### **Seed collection, storage and use for native vegetation restoration ANPC workshop**

*3 April 2013  
University of the Sunshine Coast, QLD*

This workshop will provide participants with the knowledge needed to effectively collect, store and use seed in native vegetation restoration. Topics covered include:

- developing a collection strategy
- seed collection methods
- pest and disease management
- seed banking
- seed germination & dormancy
- experts in the use of native seed will present a selection of case studies.

For more information, including a full program, flyer and registration form please visit <http://anpc.asn.au/courses.html>.

## Conferences and Workshops (cont.)

### Translocation of threatened plants ANPC workshop

4 - 5 April 2013

*University of the Sunshine Coast, QLD*

This two day workshop will provide participants with the knowledge required to effectively plan, implement and evaluate translocation projects for threatened flora. Questions addressed include:

- When is it appropriate to use translocation as a tool to conserve threatened species?
- What needs to be done when planning a translocation program?
- How should a translocation program be implemented?
- What ongoing management and evaluation is required?

The workshop will include case studies of translocation programs, highlighting lessons to be learnt and an optional full-day field trip to translocation recipient sites for a range of threatened plants.

For more information, including a full program, flyer and registration form please visit the <http://anpc.asn.au/courses.html>.

### Biodiversity offsetting for mining

9-10 April 2013

*Perth, WA*

The Biodiversity Offsetting for Mining & Energy conference will discuss the major challenges that resource proponents face to find and deliver biodiversity offsets.

This conference will provide federal and state policy updates and present industry case studies addressing key issues with biodiversity offset delivery. Understanding this complex legislative and approvals process will assist proponents to achieve positive project outcomes. For more information visit <http://biodiversityoffsetswa.com>

### EcoArts Conference

12-13 May 2013

*Wollongong, NSW (with web connection to Armidale, NSW)*

The EcoArts Australis annual conference is an opportunity for you to network and communicate with others who using the arts in creative ways to foster environmental sustainability. Themes for the conference are:

- the place of the arts in working towards environmental sustainability
- the arts in natural resources management to foster community resilience and communicate the message
- the arts in environmental education
- the arts in communicating about the environment
- creating empathy for the environment through the arts
- integrating the arts into environmental sustainability
- the arts in fostering the eco-city
- the arts in environmental activism.

For more information visit <http://www.ecoartsaustralis.org.au/conference/>

## ANPC Corporate Members

*ANPC gratefully acknowledges the support of the following corporate members*

**Albury Botanic Gardens, NSW**  
**Australian National Botanic Gardens, ACT**  
**Botanic Gardens of Adelaide, SA**  
**Centre for Australian National Biodiversity & Research**  
**Department of Environment and Conservation, WA**  
**Department of Primary Industry, NSW**  
**Department of Sustainability and Environment, VIC**  
**Environmental Assessment Branch,**  
**Department of Sustainability, Environment, Water,**  
**Population and Communities**

**Heritage and Wildlife Division,**  
**Department of Sustainability, Environment, Water,**  
**Population and Communities**  
**Mackay Regional Botanic Gardens, QLD**  
**Murrumbidgee Catchment Management Authority**  
**Royal Botanic Gardens and Domain Trust, NSW**  
**Royal Botanic Gardens Melbourne, VIC**  
**Royal Tasmanian Botanical Gardens, TAS**  
**Sydney Olympic Park Authority, NSW**  
**University of Melbourne, Burnley Campus, VIC**

Australian Network for Plant Conservation, Inc

presents a workshop on

## Plant identification for grassy ecosystems

Australian National Botanic Gardens, Clunies Ross Street, ACTON, ACT  
13–14 March 2013

This two day workshop will introduce participants to grassy ecosystems, their diversity, ecology and provide the skills and information required to positively identify a range of common grassland plants.

Learning will be through a combination of theory presentations and field-based activities.



Australian Network for Plant Conservation

presents a workshop on

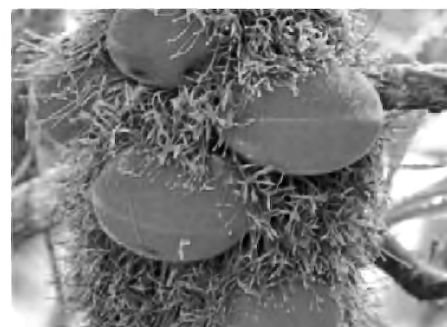
## Seed collection, storage and use for native vegetation restoration

3rd April 2013, University of the Sunshine Coast, Queensland

This workshop will provide participants with the knowledge needed to effectively collect, store and use seed in native vegetation restoration.

Experts in the use of native seed will presented a selection of case studies.

*Combine the Seed and Translocation workshop for a 20% discount*



Australian Network for Plant Conservation

presents a workshop on

## Translocation of threatened plants

4th & 5th April 2013, University of the Sunshine Coast, Queensland

This two day workshop will provide participants with the knowledge required to effectively plan, implement and evaluate translocation projects for threatened flora.

The workshop will include case studies of translocation programs, highlighting lessons to be learnt and also full-day field trip to translocation recipient sites for a range of threatened plants.



For further information, including workshop fees, full program and registration details, visit the ANPC website [www.anpc.asn.au](http://www.anpc.asn.au) and click on courses and workshops. Alternatively contact the ANPC national office on [anpc@anpc.asn.au](mailto:anpc@anpc.asn.au) or (02) 6250 9509.



Australian Network for  
Plant Conservation Inc